

















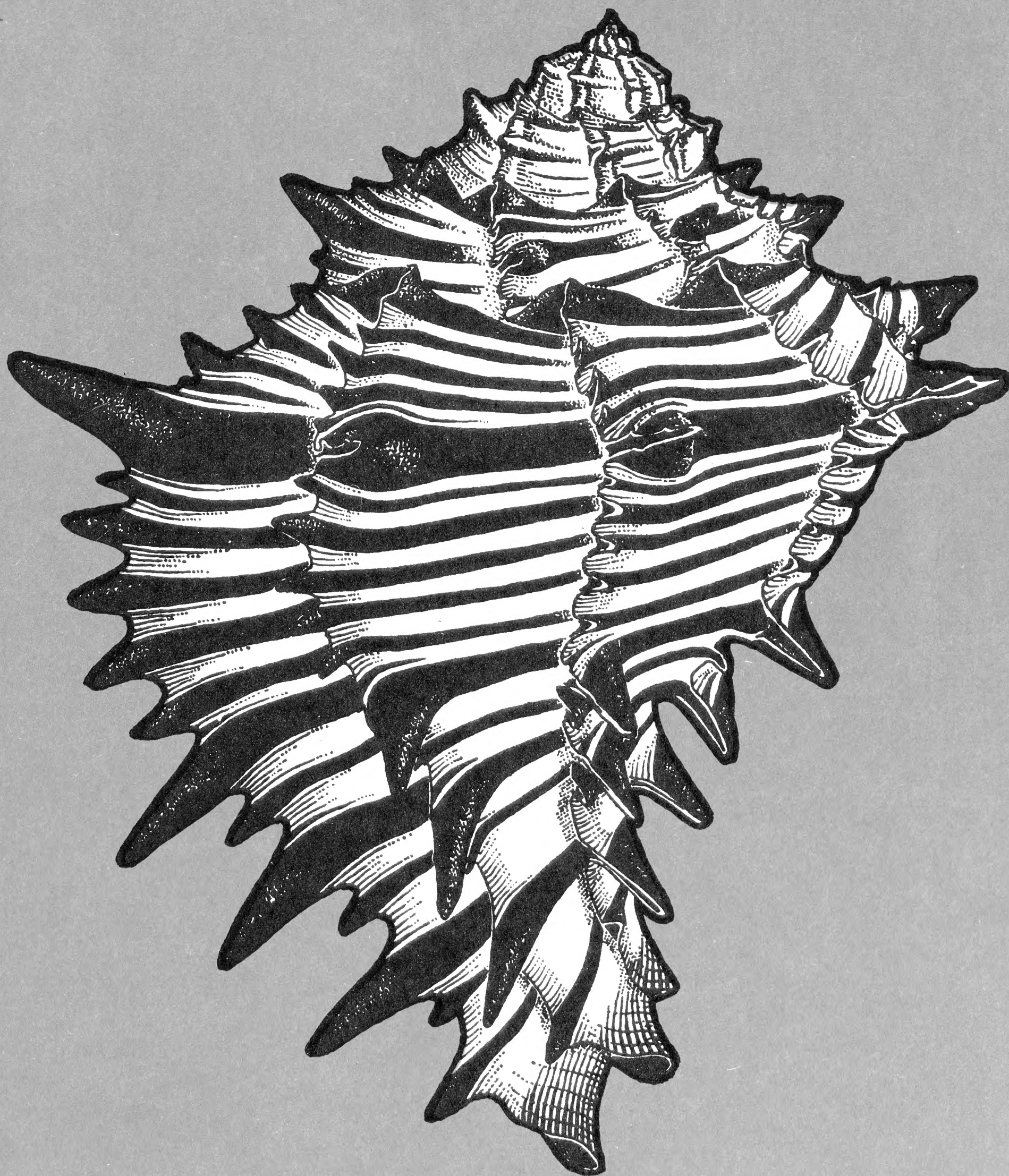
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# THE DISPERSAL OF TERRESTRIAL GASTROPOD SPECIES IN THE GULF OF GUINEA

A. GASCOIGNE<sup>1</sup>

(Accepted for publication, February 19th, 1994)



**Abstract:** The introduction of two species, *Archachatina marginata* (Swainson) and *Opeas pumilum* (Pfeiffer), to the island of São Tomé is reported for the first time. A discussion of modes of dispersal of terrestrial gastropod species in the Gulf of Guinea, focussing on the islands of Príncipe, São Tomé and Annobon, is presented.

**Key words:** Gulf of Guinea, Dispersal, *Archachatina marginata*, *Opeas pumilum*.

## INTRODUCTION

The three islands of Príncipe, São Tomé and Annobon form the southern part of the Cameroon Line of Tertiary to Recent volcanoes that also includes the continental island of Bioko (formerly Fernando Po) and stretches to the Bambouto and Oku volcanoes in Cameroon (Fitton 1980: 133) (Fig. 1 and Table 1). Bioko and Annobon are part of

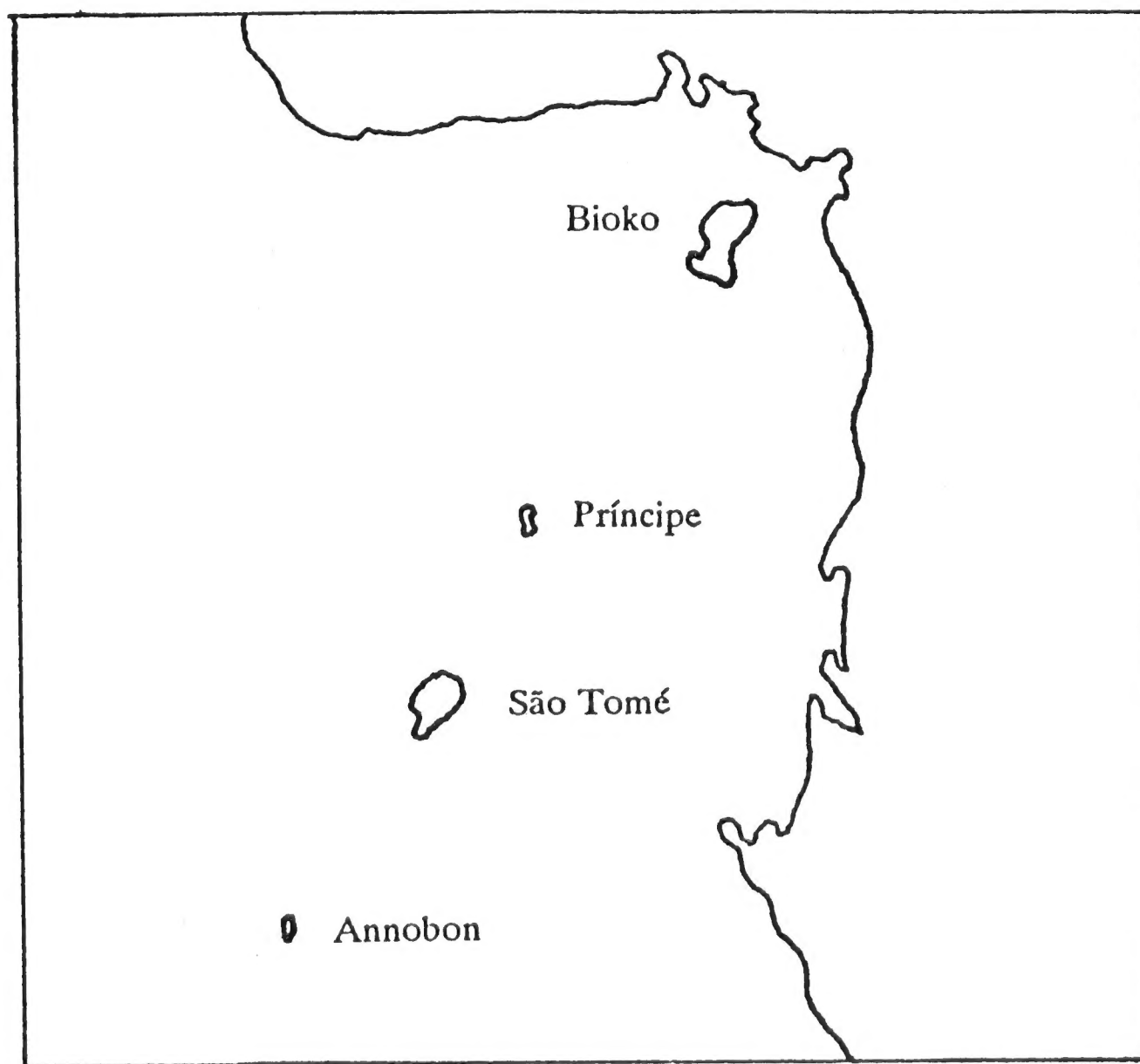


Fig. 1. Map of the Gulf of Guinea.

<sup>1</sup> CP 289, São Tomé, São Tomé e Príncipe.

TABLE 1

Distances in kilometres between the islands of the Gulf of Guinea

	Continent	Bioko	Príncipe	São Tomé
Bioko	32			
Príncipe	220	220		
São Tomé	280		146	
Annobon	340			180

TABLE 2

Endemic species found on two or more islands in the Gulf of Guinea

<i>Species</i>	<i>Islands</i>
<i>Streptostele moreletiana</i> Dohrn	Príncipe, São Tomé
<i>Streptostele truncata</i> Germain	Bioko, Annobon
<i>Archachatina bicarinata</i> (Bruguière)	Príncipe, São Tomé
<i>Pseudopeas crossei</i> Girard	Bioko, Príncipe
<i>Allopeas dohrni</i> (Girard)	Príncipe, São Tomé, Annobon
<i>Allopeas greefi</i> (Girard)	Príncipe, São Tomé, Annobon
<i>Allopeas pauper</i> (Dohrn)	Príncipe, São Tomé

TABLE 3

Non-endemic species found on Príncipe, São Tomé and Annobon

<i>Species</i>	<i>Islands</i>
<i>Trochozonites adansoniae</i> (Morelet)	Annobon
<i>Trochozonites folini</i> (Morelet)	Príncipe (also Bioko)
<i>Edourdia eminulus</i> (Morelet)	Príncipe, São Tomé
<i>Rhachistia neurica</i> (Reeve)	Príncipe, São Tomé (also Bioko)
<i>Archachatina marginata</i> (Swainson)	São Tomé (also Bioko)
<i>Subulina striatella</i> (Rang)	Príncipe, São Tomé, Annobon (also Bioko)
<i>Subulina angustior</i> (Dohrn)	Príncipe (also Bioko)
<i>Opeas pumilum</i> (Pfeiffer)	São Tomé
<i>Allopeas gracile</i> (Hutton)	Annobon
<i>Quickia concisa</i> (Morelet)	Príncipe, São Tomé, Annobon
<i>Pseudoveronicella liberiana</i> (Gould)	Príncipe, São Tomé (also Bioko)

Equatorial Guinea, a former Spanish colony whilst the two middle islands form the Democratic Republic of São Tomé e Príncipe, a former Portuguese colony. The three islands, Príncipe, São Tomé and Annobon were never connected to each other nor to the continent and were uninhabited when found by the Portuguese at the end of the 15th century.

The majority of terrestrial gastropod species of the three islands of Príncipe, São Tomé and Annobon are single-island endemics. Five species are endemic to more than one of the three islands with a further two species endemic to one of the three islands and Bioko (Table 2). Five continental species are found on two or more of the three islands with six species found on Bioko and one or more of the other islands (Table 3).

Current knowledge of the terrestrial gastropod fauna of the islands largely results from the work of Nobre, Girard and Germain who studied material collected by Newton from 1885–1895 and Fea from 1899–1901. Both Newton and Fea spent short periods in Annobon in 1892–93 and 1902 respectively. Annobon was again visited in 1957 by Knut Brystrom of



the Museum of Stockholm and in 1959 by the Peris-Alvarez Expedition (Ortiz de Zarate & Alvarez 1960).

### NEW RECORDS FOR SÃO TOMÉ

#### Family Subulinidae

##### *Opeas pumilum* (Pfeiffer)

*Opeas pumilum*, a pan-tropical species, has been collected by the author in two similar locations in São Tomé city in the north-east of São Tomé (Fig. 2). Both locations were damp and specimens were found near to or feeding on a green algae. It has not been found at other locations in surrounding cocoa plantation nor at higher altitudes in other parts of the island. Identification by Mr. F. Naggs (NHM).

#### Family Achatinidae

##### *Archachatina marginata* (Swainson)

*A. marginata* has been collected at Blublu (50m asl) in leaf-litter in shaded cocoa plantation and at Aldea (Aldeamento de Monte Café – 725m asl) in leaf-litter in shaded coffee plantation (Fig. 2). It has also been observed in the west of the island at Ponta Furada (120m asl).

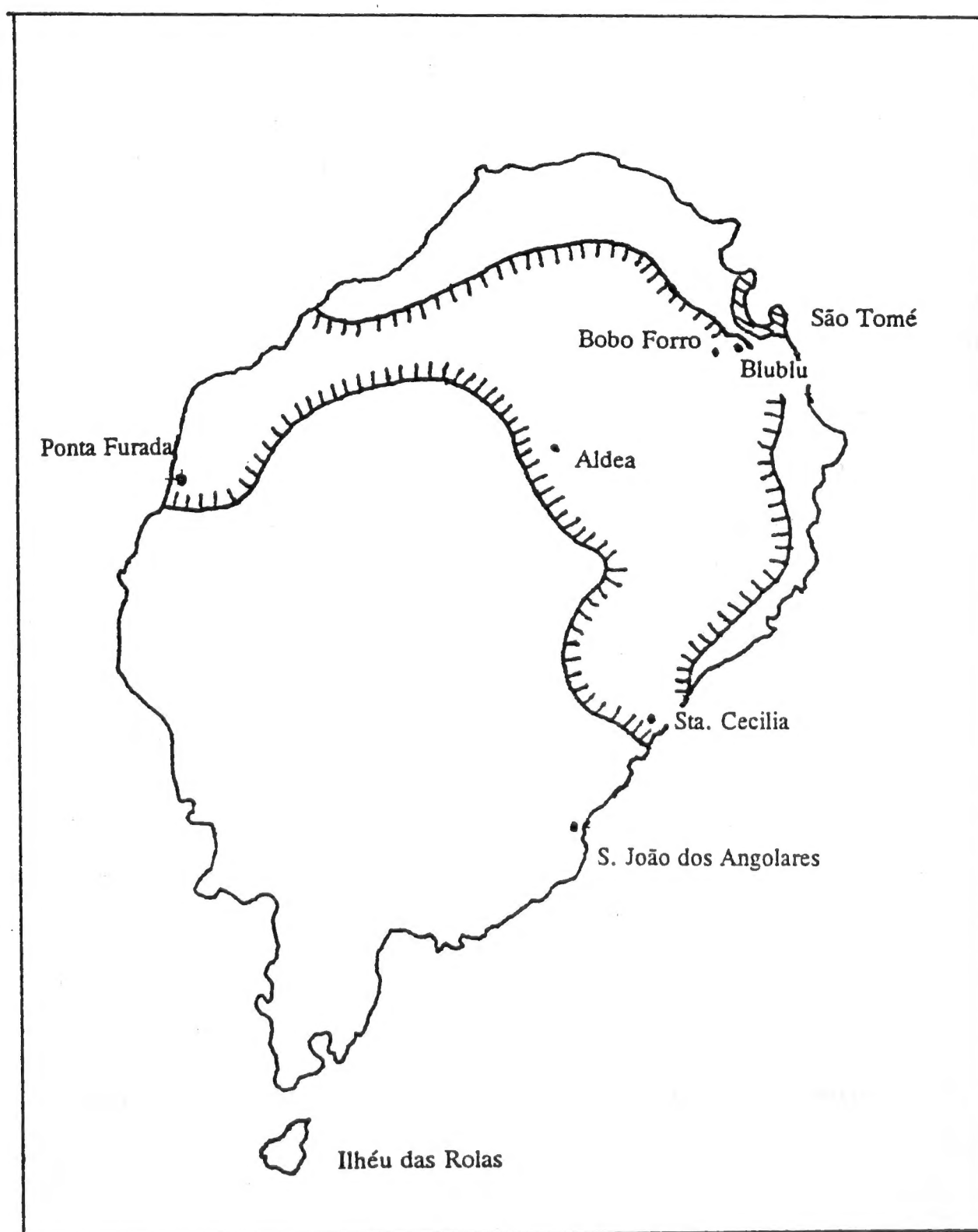


Fig. 2. Map of São Tomé showing collection locations of *O. pumilum* and *A. marginata* showing probable range of the latter.

The species is not found in the S. João dos Angolares area in the south-east, the limits of its range probably being situated in the Sta Cecilia area (Fig. 2). Observations suggest that it is absent in high altitude areas and primary and secondary forest. It appears to be absent from the south and south-west.

The species is commonly eaten and now appears to be more abundant than the endemic (São Tomé and Príncipe) and preferred *A. bicarinata*. Anecdotal evidence suggests that it has been introduced within the last thirty or forty years. Correspondents born in the 1950s do not remember it from their childhoods and have noted its increasing proximity to the city. One widely heard explanation is that it was introduced by expatriate workers from the former German Democratic Republic at Bobo Forro on the edge of the capital city in the late 1970s. It has not yet been established whether the species was also introduced to Príncipe.

Newton and other collectors found *A. bicarinata* to be common throughout the island including at low altitudes (Girard 1893). However, since that time the species appears to have declined in the north and east of São Tomé. Whether this is due to direct competition with *A. marginata*, the effect of disease or parasites introduced with this species, or unrelated environmental factors is not known. Certainly, most collecting took place before or at the beginning of the cocoa boom in the early years of this century suggesting that there was far more extant primary forest at that time. Identification confirmed by Mr. F. Naggs (NHM).

## DISCUSSION

Two explanations may be put forward for the presence of those endemics which are found on more than one of the islands. Firstly, they may represent relict species that originally arrived on two or more islands from the continent where they have since become extinct. Relict species are generally associated with islands that were once connected with larger land masses and that have since become isolated through movement of tectonic plates, sinking of the land mass or a rise in sea-level. Bioko was joined to the mainland at several times during periods of glaciation in the Pleistocene (Juste & Ibañez 1993). Its fauna, with its far lower level of endemism, may therefore be partly composed of relict taxa. Endemic taxa on the other islands have probably arisen through radiation after accidental colonisation by individuals.

Alternatively, a single-island endemic, whether a relict or a speciation type, may have been transported by some means to a second island. Species shared by two or more islands and also present on the continent may have arrived either from the continent or another island. However, the possibility of naturally occurring dispersal between the islands is relatively unlikely considering their small size and distance from each other in comparison with the far greater possibility of introduction from the mainland. Exell (1944), considering the flora of the islands of Príncipe, São Tomé and Annobon, noted that of 171 endemic species only eleven (6.4%) occur on two or more islands and that each island has a comparatively large number of species which are found on the continent but not on the other islands. Although in the case of terrestrial gastropods dispersal of endemics between the islands is similarly low (7.6%), of the twelve continental species found on Príncipe, São Tomé and Annobon only four are restricted to one of the four islands.

On Bioko the large number of continental species, both in absolute terms and as a percentage of the total number of species, may have arisen in a number of ways. Firstly, these species may have become isolated from continental populations when the island was separated from the mainland. Secondly, given the short distance between the island and the continent, natural dispersal is more probable than for the other islands. However, it is noted that Bioko has an indigenous human population, the Bubi, and that, even in the colonial period, contact with the mainland was far greater than for the other islands. Other factors,



such as its higher altitude and larger number of plant species (both endemic and continental) would suggest a more diverse range of habitats providing more niches for both indigenous and colonising species.

Apart from the introductions to São Tomé reported in this paper, only two other introductions have been documented. Ortiz de Zarate & Alvarez (1960) noted the presence of two species on Annobon, *Streptostele truncata* Germain and *Subulina striatella* (Rang), that had not previously been collected by Newton or Fea. They concluded that these species had been introduced in the intervening period and in the case of *S. truncata*, noted that it had not spread beyond the confines of the one permanent settlement in the north of the island. As *S. truncata* is endemic to the island of Bioko (Germain 1915: 286), it was almost certainly introduced as a result of human movement between the two (formerly Spanish) islands.

If the other endemic species shared by two or more islands are not considered to be relicts, then dispersal between the islands must have occurred. During the last glaciation, when the sea level dropped by about 100m, Príncipe would have been significantly larger in area (c. 1000 km<sup>2</sup>) than it is now (140 km<sup>2</sup>) (Juste & Ibañez 1993). This may explain the fact that the number of gastropod species on Príncipe, despite its smaller current area, approaches the number of species found on São Tomé (31 and 38 species respectively, including known recent introductions). Correspondingly, Príncipe would have been closer to the island of São Tomé (c. 110 km) thus increasing the likelihood of natural dispersal. However, a consideration of recent historical links between the islands would suggest that such dispersal may have occurred through deliberate or accidental human introductions. Thus the presence of *Archachatina bicarinata* (Bruguière) on both São Tomé and Príncipe may be explained by its importance as a food source for the local population – having been found on one island it was deliberately introduced to the other. Although first described from Príncipe at the end of the 18th century, it was well established on São Tomé when found by Welwitsch in the middle of the 19th century and was also found on Ilhéu das Rolas, a kilometre off the southern end of São Tomé, by Greeff in the early 1880s (Girard 1893: 109). It is not therefore possible to state from which island it originated. It is still eaten in São Tomé e Príncipe although the recently introduced and more common *Archachatina marginata* is now more important in this respect. This author has not come across the consumption of the eggs of *A. bicarinata* as Girard (1893: 109) reports.

Other endemic species, such as those of *Allopeas* Baker, may have spread with the transportation of plants and food crops from one island to one or more other islands. Although there is little documentation on the introduction of plants, it is known that cocoa was first introduced to Príncipe in 1822 and then taken from Príncipe to São Tomé in 1855 (Exell 1944: 7). At some point cocoa was also introduced to Annobon (Liniger-Goumaz 1984), although it has not been possible to ascertain an exact date or from where it was introduced. Many other food crops and ornamental plants are likely to have been introduced by humans to one island before proceeding to the other islands. Although Exell (1944) drew attention to the lack of contact between the islands under Spanish rule and those under Portuguese rule during the colonial era (as is the case now), Liniger-Goumaz's (1984) chronology of Annobon shows that intermittent contact did occur both before and during the 19th century.

Apart from *Streptostele truncata*, the only other species endemic to Bioko and another island, in this case Príncipe, is *Pseudopeas crosseii* Girard (Girard 1893: 105, Ortiz de Zarate Lopez & Ortiz de Zarate Rocandio 1959: 99). Although natural dispersal of this species is more plausible than in the case of *S. truncata* owing to the shorter distance between the islands concerned, dispersal may also have resulted from human activity.

Of the continental species found in the islands (Table 3), three, *Opeas pumilum* (Pfeiffer), *Allopeas gracile* (Hutton) and *Trochozonites adansoniae* (Morelet), are only known from one island and thus can only have arrived from the continent. All the continental species, with

one exception (see below), are known from areas around the Gulf of Guinea. However, given that dispersal of endemic species between the islands has occurred, it is not possible to state whether the other continental species arrived on each island separately, or island hopped. Only in one case, that of *Archachatina marginata*, is there some evidence that deliberate introduction for a continental source occurred.

### CONCLUSIONS

The presence of endemic species on two or more of the Gulf of Guinea islands has resulted from inter-island dispersal in at least one documented instance. It has been argued that the other shared endemics are unlikely to be relict species that survived on two or more islands simultaneously but have also dispersed as a result of deliberate or accidental introduction. Equally, it is not possible to state whether the presence of continental species on two or more islands has arisen through inter-island dispersal or independent colonisations.

Solem (1990) has suggested that no island has yet developed a "saturated" gastropod fauna. The recent discovery of two new colonisers in São Tomé and a third as yet unidentified member of the Ferrussacidae in São Tomé city, as well as the appearance of two colonisers on Annobon in the first half of this century would appear to support this view. Land use changes in the islands since they were colonised in the 15th century, and particularly over the last 150 years with the development of the cocoa and coffee plantations, have probably limited the range of some species though at the same time providing new niches for colonisers.

Given our limited knowledge of the gastropod fauna of the Gulf of Guinea islands, it is likely that other recent introductions have occurred. Thus, although *Archachatina marginata* has not been recorded from Príncipe, it would not be surprising to find that it had been introduced there given that both sea and air transportation with São Tomé are now frequent. In addition, it is possible that as yet undescribed endemic species may still exist in the montane forests of the centre and the low altitude forests of the south-west of São Tomé.

### ACKNOWLEDGEMENTS

I would like to thank Fred Naggs of the Natural History Museum, London, for his help with identification of the species concerned and his comments on early drafts of this article.

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# NEW NASSARIIDS FROM OMAN AND SOMALIA (NEOGASTROPODA: PROSOBRANCHIA) \*

R. G. MOOLENBEEK<sup>1</sup> AND H. DEKKER<sup>1</sup>

(Accepted for publication, February 19th 1994)

*Abstract:* *Nassarius emilyae* n.sp. is described from areas of Masirah and Dhofar (Oman). *N. emilyae somaliensis* n. ssp. is described from Somalia. The occurrence of both taxa in the north-western Indian Ocean is probably due to the influence of the cold water upwelling. *Bullia smytheae* n.sp. is described from Masirah Island.

*Key words:* Gastropoda, Prosobranchia, Nassariidae, *Nassarius*, *Bullia*, taxonomy, Oman, Dhofar, Masirah Island

## INTRODUCTION

As discussed in detail in other publications (UNEP, 1985, Savidge *et al.* 1990, Anderson *et al.* 1992, Sheppard *et al.* 1992) the waters around Masirah Island and the southern province of Dhofar are influenced each year by upwelling of cold, nutrient-rich water during the monsoon. Probably due to this phenomenon high endemism occurs and several endemic species have been described from this malacological El Dorado (Abbott 1973, Smythe & Chatfield 1981, Taylor & Smythe 1985, Dance *et al.* 1992, Dekker *et al.* 1992).

While preparing a book on the marine molluscan fauna of Oman and adjacent regions, we studied the species of the family Nassariidae. The species of the genus *Nassarius* are abundant and diverse in the Indo-Pacific region. They comprise a common group of neogastropods living in the intertidal zone and distributed all along the coastline of Oman. We know of about 50 species from the area. As well as some rare and/or local ones, for example *Nassarius nodulosus* (Marrat, 1873), *N. mammilliferus* (Melvill, 1897), *N. persicus* (Von Martens, 1874), we found a species we could not identify. It was also unknown to Mr. H. Kool (The Netherlands), a keen specialist in nassariids, who suggested a relationship to an unidentified species from Somalia, present in the collection of the United States National Museum (USNM). After studying and comparing all available samples, we conclude that both represent hitherto undescribed taxa.

The species of the genus *Bullia* comprise a relatively small group of neogastropods presently confined to tropical and subtropical shallow-water habitats in the South Atlantic and Indian Ocean. According to Allmon (1990) the current status of *Bullia s.s.* may represent a relatively recent development in Africa and the northern Indian Ocean. The ancestors of modern *Bullia s.s.* may have reached Africa during the late Miocene or early Pliocene from South America via chance dispersal across open ocean. Today approximately 40 living species are recognized of which about 13 are known from the northern Indian Ocean.

Little is known about the ecology and soft-part morphology of most species, and we know of no detailed research on Arabian species. From studies in South Africa we know that *Bullia*

\* Studies on the marine molluscan fauna of Oman, No. 8.

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species are opportunistic, carnivorous scavengers (Brown 1982), living in the intertidal and subtidal zones. Intertidal species seem to feed on almost any beached animal matter. All species are blind and have a non-planktotrophic larval development (Allmon 1990).

During fieldwork in November 1991 along the coast of Oman, several species were collected alive in the intertidal and subtidal zones. In a subtidally collected sample from Masirah Island we found, amongst specimens of *Bullia rogersi* Smythe, 1981, a distinct, more slender and differently coloured *Bullia* species. After comparing it with material from East Africa, we consider that it represents an undescribed species.

### MATERIAL EXAMINED

The material used in this study was collected in November 1991 during an expedition initiated by Dr. Donald Bosch. Additional samples, some of them collected during earlier collecting trips by the Bosch family, were kindly put at our disposal. All material, unless otherwise stated, is stored in the Zoölogisch Museum Amsterdam (ZMA).

### SYSTEMATIC DESCRIPTIONS

#### *Nassarius emilyae* n.sp. (Figs. 1–4)

*Description of the holotype* (Figs. 1–2): Shell length 15.78 mm, width 8.68 mm (ZMA Moll. 3.93.019). Protoconch damaged. Teleoconch of 4.5 whorls. First post-nuclear whorl with about 10 strong axial ribs. Body whorl on ventral side has 6 rather strong axial ribs; dorsal side to aperture smooth with only vague axial ribbing just below suture. Under high magnification many minute spiral lines are visible. A clear siphonal notch, above it 3–4 fine spiral grooves. Aperture entire, ovate with a narrow posterior anal slit. Anterior groove slender and deep. Columella smooth and shiny. Inner side of outer lip has 5–6 denticles. Outer lip has a strong varix and a reflected edge.

*Colour*: Below the suture a creamy white band. On the lower part of this band are irregular, black, triangular markings. At mid-body are 5 irregular bands of reddish brown dots. On the ventral side these spiral bands are on a creamy background, on the dorsal side they are on a greyish brown background. Inside of aperture dark greyish tinged purple. Soft parts and radula unknown.

*Type locality*: Sultanate of Oman, Masirah Island, Valley of the Moon beach in tidal pools, Sta. 91/93, 20 November 1991. leg. R. G. Moolenbeek & H. Dekker.

*Paratypes*: Three paratypes from Masirah Island: one from Jabal Suwayr, Sta. 91/89 (ZMA Moll. 3.93.020, length 13.2 mm); one damaged juvenile shell from Ra'a Abu Rasas, Sta. 91/90 (ZMA Moll. 3.93.021, length 7.77 mm); and one from Umm Rasas, Sta. 91/gg, (ZMA Moll. 3.93.022, length 12 mm); all specimens leg. R. G. Moolenbeek & H. Dekker, November 1991.

*Other material studied/distribution*: In the southern province of Dhofar we collected this new species in a few localities but also in limited numbers; apparently it is always scarce. On the beach at Marbat, Sta. 91/69, (3 shells, length 16.83, 14.45, and 11.97 mm resp.); Dar Marbat, beach (1 shell, length 12.36 mm) all leg. R. G. Moolenbeek & H. Dekker, 14 November 1991.



*Etymology:* This new species is named after Emily Apar, grand-daughter of Donald and Eloise Bosch.

*Discussion:* Subgeneric classification in Nassariidae is still unsatisfactory. The inflated aperture suggests a relation to the subgenus *Telasco*. However, the axial ribbing and relatively small aperture is more like *Zeuxis* or *Aciculina*.

The few shells we studied from Masirah Island and Dhofar Province vary only in size. Coloration and sculpture do not vary much. Unfortunately, we did not find specimens with intact protoconchs and/or with living animals to enable us to describe larval development and the anatomy.

Comparison with closely related species is very difficult since *Nassarius emilyae* n.sp. is very distinct from other taxa. There is a resemblance to *N. gaudiosus* (Hinds, 1844) but that species is more bulbous and generally has a smooth body whorl. In sculpture *N. exilis* (Powys, 1835) from the Panamic province is similar but differs in having very fine spiral threads all over the body whorl. In fact, there are no closely related species known for this new taxon.

Apart from the Oman population, we studied shells from Somalia (see Introduction). There are differences in sculpture and colour pattern, however, and for these reasons we consider them subspecifically distinct.

*Nassarius emilyae somaliensis* n. ssp. (Figs 5–8)

*Description of the holotype* (Figs. 5–6): As all the available specimens lack the protoconch and probably one or two of the post-nuclear whorls, an adult specimen with the most undamaged teleoconch is designated as holotype. This shell is part of a lot in the United States National Museum, Washington (USNM No. 673854). Shell length 18.38 mm, width 8.89 mm, rather shiny, solid, somewhat squat, with a glazed ceramic appearance. Body whorl more than half total length. Protoconch absent (broken off), teleoconch consisting of  $5\frac{1}{2}$  axially ribbed whorls. Ribs rounded, 14 on the penultimate whorl; on the body whorl 12 angulate and oblique ribs, becoming obsolete on the outer lip, later ribs strongest on the upper part of the body whorl. Suture distinct, ribs growing out of the suture. Outer lip thickened and broadly variced, more concave than the columella, which gives the aperture an asymmetrical shape. Inner side of outer lip has 8 lirae. Strong columellar tooth, well defined anal canal. Columellar callus thick and well bordered, with 4 fine denticles and a pleat at the end. Siphonal fasciole with 6 cords. Microscopic, slanting growth lines all over the shell. Radial sculpture limited to 3 basal cords.

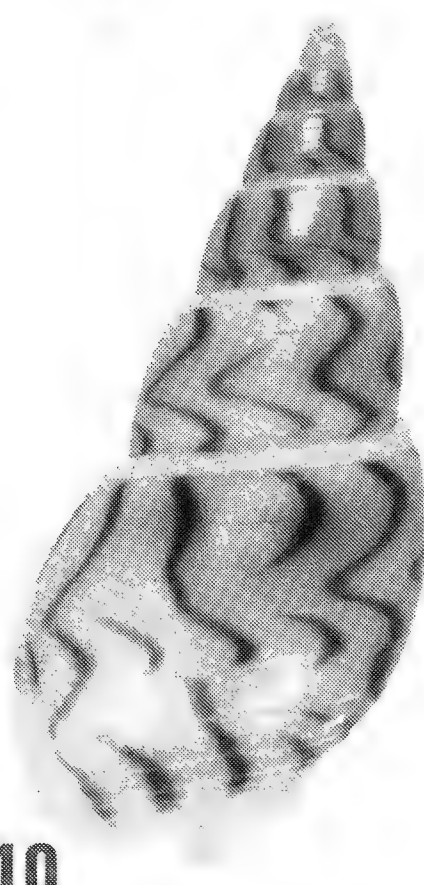
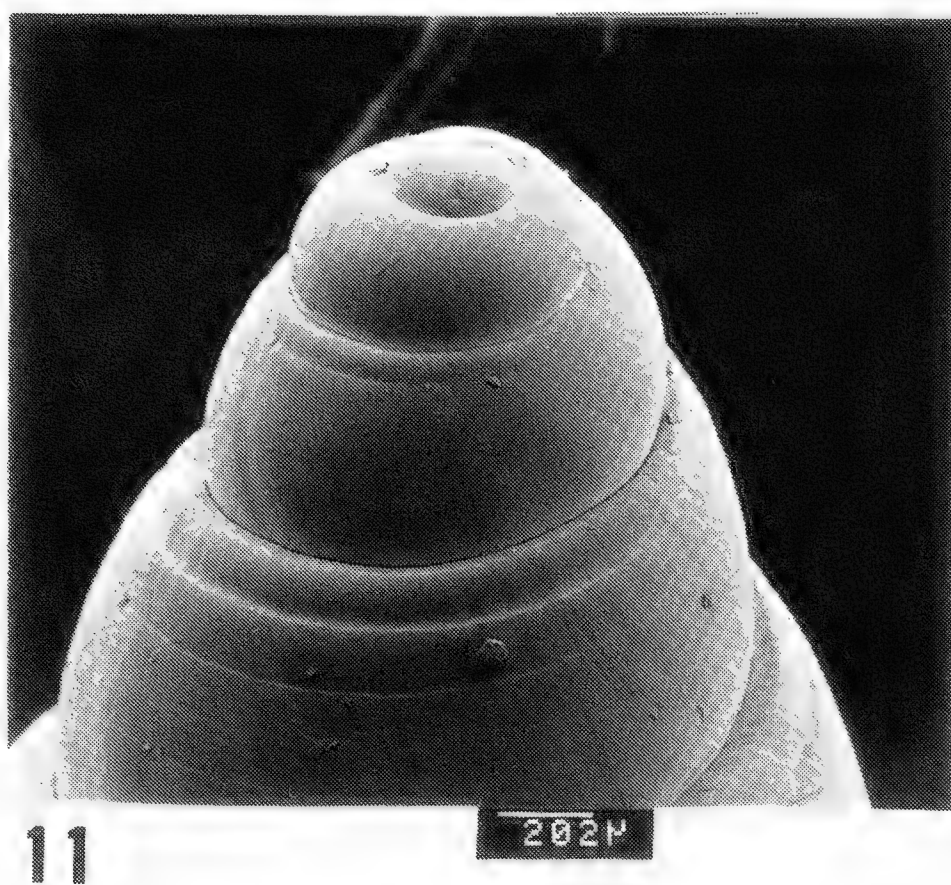
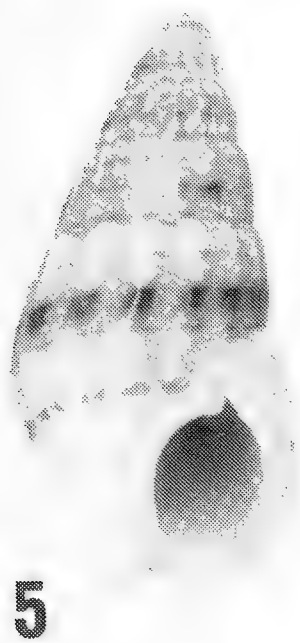
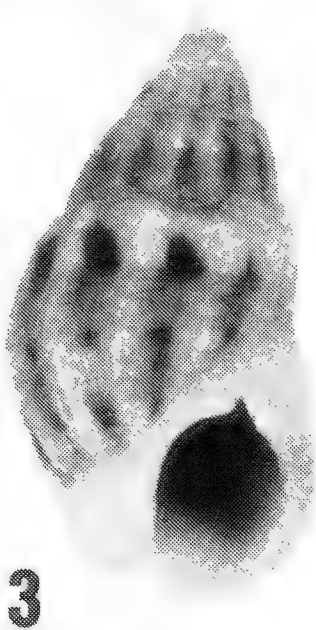
*Colour:* Cream, one yellow-brown band and two lines on the penultimate whorl; on the body whorl one yellow-brown band between two lines, strongest on ribs and three other lines.

*Type locality:* Somalia, Mogadishu, leg. D. Emrich.

*Paratypes:* Apart from the holotype, the type lot consists of 9 paratypes, varying in length from 8.63–16.45 mm (7 in United States National Museum [USNM No. 887024], and one each in the Zoological Museum Amsterdam [No. ZMA Moll. 3.93.023] and in the private collection of H. Kool, The Netherlands).

In USNM [No. 754969] 2 additional paratypes (length 16.65 and 15.24 mm) from Mogadishu, Somalia [Acc. 320140 *ex* A. P. White].

*Variability:* The differences between the holotype and the other specimens from Somalia are mainly in size and pattern. The length of adult shells varies from 12–16 mm, some of them





with one broad yellow-brown band; compared with the narrow-banded holotype, the basic cream colour is limited to the upper half of the ribs on these shells.

In lot USNM No. 673854 is a subadult specimen with a teleoconch of 6 whorls. Comparison of this specimen with a very juvenile specimen in the same lot makes it probable that adult individuals have a teleoconch of 6 whorls.

The most important difference from the Oman specimens is that they show locally very fine microscopic grooves. The colour pattern varies in details, see Figs. 1–4 and 5–8.

This species was already figured by Di Geronimo & Robba (1979) from Somalia as *Nassarius* sp. 2.

***Bullia smytheae* n. sp. (Figs. 9–11)**

*Description of the holotype* (Figs. 9–10): Shell bucciniform, small, glossy. Shell length 16.3 mm, width 7.9 mm (ZMA Moll. 3.93.024). Protoconch mammillate, smooth, translucent and glossy, probably of non-planktotrophic larval development. Teleoconch whorls rounded, suture deeply incised and with a spiral cord below it. Body whorl relatively large and inflated, spire elongated. Whorls convex, smooth, anterior part with 8–9 weak spiral grooves. About 8 coarse cords on the fasciole. Aperture ovate, entire with a simple outer lip. Anterior canal short, narrow but deep.

Animal eyeless, cephalic tentacles slender and long.

Operculum denticulate at margin, length 4.6 mm, width 2.8 mm (Fig. 16).

*Colour*: Protoconch glassy; teleoconch whorls whitish grey with fine, undulating, axial, reddish-brown lines. On the body whorl these axial lines run from below the ivory-white spiral cord below suture to the whitish fasciole.

*Type locality*: Sultanate of Oman, Masirah Island, Ra's al Ya, in sand; found subtidally, leg. R. G. Moolenbeek & H. Dekker, 23.XI.1991.

*Paratypes*: Apart from the holotype we collected 11 paratypes from the type locality. In 1991 Dr. D. T. Bosch collected another 88 paratypes from the type locality.

Apart from size this species is quite uniform in appearance. Only the reddish-brown axial markings show some minor differences. Paratypes will be donated to the Oman Natural History Museum, National Museum of Wales, National Museum of Washington, Natal Museum and the private collections of S. P. Dance, H. Dekker, P. L. van Pel, and D. Smits.

*Other material studied*: Sultanate of Oman, Masirah Island, Sur (Sta. 91/102), 5 shells, leg. R. G. Moolenbeek & H. Dekker, November 1991; Sur, 4 shells, leg. D. T. Bosch, 1989; Safa 'IQ, 3 shells, leg. W. Howard, March 1989; Valley of the Moon, 2 shells, leg. S. P. Dance, February 1989.

Figs. 1–4. *Nassarius emilyae* n.sp. Oman. 1–2 holotype, Masirah Island, Valley of the Moon beach, length 15.78 mm. 3. paratype, Masirah Island, Jabal Suwayr, length 13.2 mm. 4. Province of Dhofar, Marbat, length 14.45 mm.

Figs. 5–8. *Nassarius emilyae somaliensis* n.ssp. Somalia, Mogadishu. 1–2. holotype, length 18.38 mm. 7. paratype ventral view, length 16.65 mm. 8. paratype ventral view, length 15 mm, all USNM.

Figs. 9–11. *Bullia smytheae* n.sp. Oman, Masirah Island, Ra's al Ya. 9–10. holotype, length 16.3 mm. 11. SEM picture of paratype, protoconch and first postnuclear whorl.

Figs. 12–13. *Bullia aikenii* Kilburn, 1978, Mozambique, Porto Amelia, holotype (Natal Museum G8916/T2152), length 12.6 mm.

Fig. 14. *Bullia tranquebarica* (Röding, 1798), Oman, Muscat, length 25.0 mm.

Fig. 15. *Bullia rogersi* Smythe, 1981, Oman, Masirah Island, length 19.6 mm.



Fig. 16. Operculum of *Bullia smytheae* n.sp.

*Etymology:* This new *Bullia* is named after the late Mrs. Kathleen R. Smythe, one of the pioneer students of the Oman malacological marine fauna.

*Remarks:* *Bullia smytheae* n.sp. lives sympatrically with *B. rogersi* Smythe, 1981. It differs from the latter by being smaller, more slender and by lacking the spiral grooves on the first post-nuclear whorls. Very characteristic are the undulating axial red-brown lines whereas *B. rogersi* has more axial wavy lines (Fig. 15). At first sight it looks identical to *B. aikeni* Kilburn, 1978 from Mozambique, but after studying type material we are convinced that this is a different species. *B. aikeni* has a more blunt protoconch, is more slender and has a relatively smaller aperture (Figs. 12–13). Also the spirals at the base are more pronounced and fewer (about 5). The colour pattern of *B. aikeni* differs in having less regular, axial, brown stripes. The operculum of *B. aikeni* is smooth whereas that of *B. smytheae* has a denticulate margin. Another species we compared with *B. smytheae* was *B. osculata* (Sowerby, 1900) from South Africa. That species, however, has no spiral grooving at all and lacks the axial colour pattern. The common *B. tranquebarica* (Röding, 1798) from Oman has rather straight and more numerous axial lines (Fig. 14).

#### ACKNOWLEDGEMENTS

We are grateful to Dr. D. T. Bosch for enabling us to participate in this project and to him and his wife Eloise for help and hospitality during our stay in Oman. Thanks are due to the staff of the BERS station on Masirah Island for accommodation and support. Peter and Una Dance, Christine and Valter Hägstrom, Donald and Eloise Bosch were companions during our collecting activities and always helpful. KLM Oman (Mr. J. W. Creutzberg and J. Simpson) kindly arranged a courtesy ticket from Amsterdam to Seeb. Drs R. Kilburn and D. Herbert kindly sent types of South African *Bullia* species on loan. Hugo Kool gave his view on the new nassariid and drew our attention to the material in the USNM (this was kindly sent on loan by Dr. A. Kabat). Dr. H. E. Coomans and two unknown reviewers corrected the English text. The photographs were made by L. A. van der Laan (ZMA). The SEM photo was made at the Laboratorium voor Elektronenmikroskopie (University of Amsterdam) by the first author.

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MOOLENBEEK & DEKKER: NEW NASSARIIDS FROM OMAN AND SOMALIA

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# TAXONOMY OF ARABIAN BIVALVES

## PART 1. ARCOIDEA

P. G. OLIVER<sup>1</sup> AND H. C. G. CHESNEY<sup>2</sup>

(Accepted for publication, February 19th 1994)

**Abstract:** New taxa of arcoid bivalves are described from the Arabian Sea. *Arca symphenacis* n. sp., *Arca* (*Tetrarca*) *acuminata dayi* n. ssp. and *Anadara pesmatacis* n. sp. are restricted to the cold water upwelling region of Oman. *Barbatia perinesa* n. sp. ranges from Masirah to the Mekran Coast. Some of these species have close affinities with taxa from the warm temperate waters of southern Africa. *Noetiella chesneyi* is a new name for the preoccupied *N. minor* Pallary which is found only at the northern end of the Arabian Gulf.

**Key words:** Taxonomy, Bivalvia, Arcoidea, Arabian Sea.

### INTRODUCTION

The shelled marine molluscs of Oman and the Arabian Gulf are currently being reviewed in preparation for an identification manual. This project, organised by Dr. Don Bosch, has allowed us to examine and collect extensive quantities of material from this region. This material contains many poorly known and some new bivalve taxa which require full description before inclusion in the manual. This is the first paper of a short series and deals with the problematic Arcoidea from these collections.

In this and subsequent papers we use some statistical analyses to quantify differences in shell shape and sculpture. These are computed and the graphics created by Statview<sup>TM</sup>. We are however not employing numerical taxonomy as a rigid method as morphological differences can have a variety of underlying causes which may well not be at the species level. The statistics are used only to give some empirical data to facilitate further comparisons with other taxa.

#### **Superfamily Arcoidea**

#### **Family Arcidae**

#### **Genus *Arca* Linnaeus, 1758**

Type species *Arca noae* Linnaeus, 1758

#### ***Arca symphenacis* n. sp.**

*Arca ventricosa* Lk. Bosch & Bosch, 1982: 149.

*Arca ventricosa* Lk. Bosch & Bosch, 1989: 79.

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*Material*

*Holotype*: NMW. Z. 1993. 003.01. One complete specimen from the Umq-Haql region of Masirah, Oman. 20°21'N 58°48'E. coll. Martyn Day, 24. xii. 92.

*Paratypes*: NMW. Z. 1993. 003.02. and ZMA. as holotype.

*Other material examined*: 11v. "No exact locality, Part of Don Bosch's general collection from Oman. 1v, BERS Camp, Masirah, 21°42'N 58°53'E, coll. P. G. Oliver/H. C. G. Chesney, 24 x. 1992. 1v, Ras Himari, [Masirah], 20°19'N 58°48'E, coll. S. P. Dance, 19. x. 1991, 3v, Haql, Masirah, 20°21'N 58°48'E, coll. S. P. Dance, 20. x. 1991, 4v, Haql, Masirah, 20°21'N 58°48'E, coll. M. Day, 17. vi. 1993. 1v, Maghilah (Macula) Masirah, 20°25'N 58°49'E, coll. M. Day, 10 iii. 93. 3v, Urf, Masirah, 20°12'N 58°42'E, coll. M. Day, 10 ii. 93. 2v, Urf, Masirah, 20°12'N 58°42'E, coll. M. Day, 14 v. 93. 1v, Mirbat, Dhofar, 17°0'N 54°40'E, coll. S. P. Dance, 14. xi. 1991. 1v, Rakhyut, Dhofar, 16°50'N 53°25'E, coll. S. P. Dance, 13. xi. 1991.

Specimens in Oman Natural History Museum from Mirbat, Dhofar, 17°0'N 54°40'E. Raysut, Dhofar, 16°55'N 54°00'E. Shark Island, Dhofar. Khor Rowri, Dhofar.

*Description*: To 62 mm in length. Shell moderately thick but brittle. Equivalve. Strongly inequilateral, beaks close to the anterior margin. Outline trapezoidal; anterior narrow and usually pointed, curving evenly into the long gently sloping ventral margin, byssal notch weak causing a slight sinuosity. Posterior flared, posterior margin indented and truncated. Posterior carina weak, posterior area sulcate but median byssal sulcus weak. Dorsal margin very long and straight, dorsal area flat and large, beaks widely separated. Ligament with many chevrons covering most of dorsal area. Sculpture of narrow radial ribs and riblets, posterior area with one to four weak ribs; anterior and median areas with about 25 primary ribs with single secondaries between anterior ribs but with one to three secondaries between median ribs. Periostracum often persistent of straw coloured lamellae except on posterior carina where there is a row of large spathulate bristles. Hinge line straight, teeth very small, Holotype with 32 in anterior set, 66 in posterior set. Adductor scars unequal, the posterior twice the size of anterior; byssal retractor scar very large. Inner margin smooth or with weak crenulations along posterior and anterior margins. Shell white with rust brown transverse or zigzag bands, posterior area usually a more uniform brown; internally white with reddish brown shading over posterior area.

*Measurements*

Length mm	Height at Umbo	Max Height	Anterior Length	Anterior + Median primary ribs	Tumidity (Single valve)
H55.1	14.2	23	12.7	25	12.4
P53.3	14.4	23.3	16.0	24	11.3
P49.8	16.6	24.3	13.0	26	10.4
53.5	14.2	23.5	13.8	24	14.5
53.1	14.0	22.2	14.6	26	12.9
52.0	13.5	22.9	12.7	25	14.3
43.9	11.7	20.7	11.3	27	10.6
43.0	12.4	18.3	10.0	23	11.3
39.8	11.1	17.9	11.3	25	9.0
38.9	13.2	18.6	10.5	23	9.2
33.0	10.2	15.2	9.7	24	7.9
30.6	10.8	14.8	7.8	24	7.5



*Derivation of name:* *symphenacis*, from the Greek, *symphenakos* meaning “partner in deceit” and relating to the confusing similarity of *Arca* species in the *noae* group.

*Distribution:* Khor Rawri; Raysut; Shark Id., Dhofar; Mirbat; Umq–Haql region of Masirah; Ras Hilf, Masirah. Range from Dhofar to Masirah. We cannot confirm this species from north of Masirah although Don Bosch states that it occurs as far north as Muscat.

*Remarks:* *Arca symphenacis* belongs the group containing *A. noae*, *A. navicularis* and *A. zebra* and not to the group of *A. avellana* and *A. ventricosa*. The primary difference between these groups is the presence of distinct radial ribs over the whole shell in the *noae* group but with a decussate sculpture in the *avellana* group. The reason for the misidentification by Bosch (1982:89) was likely to have been the crowded nature of the ribs in *A. symphenacis* as distinct from the more prominent wider spaced arrangement in *A. navicularis* the only other Indian Ocean species related to it. The difference in rib number between *A. symphenacis* and *A. navicularis* is illustrated in Figure 1 and can be seen in Plate 1.

The two species also differ in shape; *A. symphenacis* is proportionately narrower, is more inequilateral and more attenuate anteriorly. These comparisons are illustrated in Figure 2. The specimens of *A. navicularis* used came from Mozambique, Red Sea, Singapore, Western Australia and off Hong Kong.

*Arca symphenacis* is another species endemic to the Dhofar–Masirah section of the Omani coast. It does not overlap with *A. navicularis* and because of the considerable differences in form we cannot regard it as a local race or ecophenotype. The narrow outline and narrow ribs give *A. symphenacis* a closer resemblance to *A. noae* from the Mediterranean than to *A. navicularis*. Whether this has some biogeographical implication is conjectural but this would seem to be another case where a species from the Southern Arabian upwelling area has affinity outside the Indo-Pacific fauna.

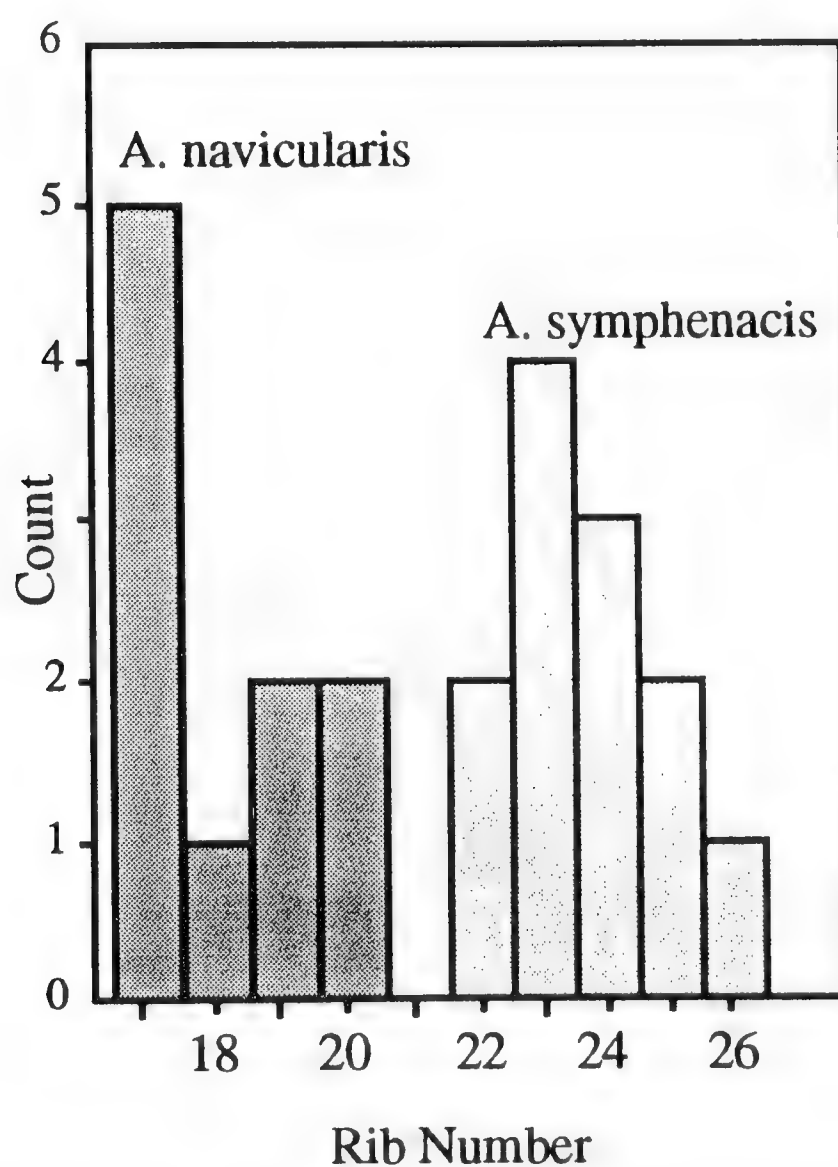


Fig. 1. Bar chart showing the frequency distributions of the primary rib number for *Arca symphenacis* and *A. navicularis*.

*Arca avellana* occurs across the southern Arabian peninsula but its close relative *A. ventricosa* is absent from, but straddles, the Dhofar–Masirah section. With *A. navicularis* it is replaced by *A. symphenacis*. Why within a genus one should find such variation in distribution pattern is not understood and serves only to reflect the extreme lack of ecological data that we have for the bivalves of the Indian Ocean.

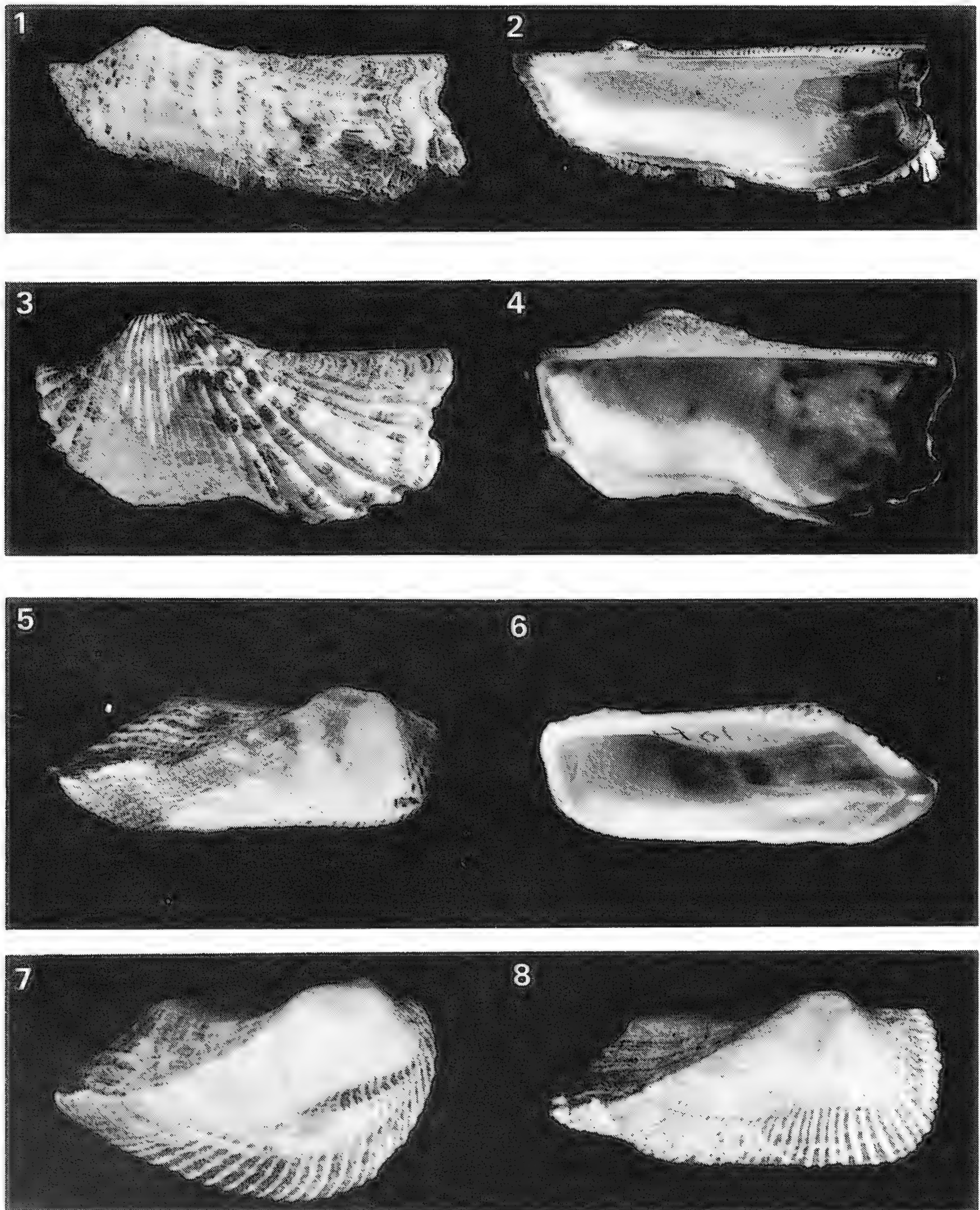


PLATE 1

- Figures 1–2. *Arca symphenacis* n. sp. Holotype. NMW.Z.1993.003.01. Length = 55.1 mm.  
 Figures 3–4. *Arca navicularis* Brug. Moreton Bay, Queensland. NMW.Z.1984.093.09. Length = 64.4 mm.  
 Figures 5–6. *Arca (Tetrarca) acuminata dayi*. Holotype. NMW.Z.1993.003.03. Length = 22.1 mm.  
 Figure 7. *Arca (Tetrarca) acuminata* Krauss. Natal. NMW.1955.158.1627. Length = 22.2 mm.  
 Figure 8. *Arca (Tetrarca) tetragona* Poli. Ireland. NMW.1955.183.014. Length = 22.2 mm.

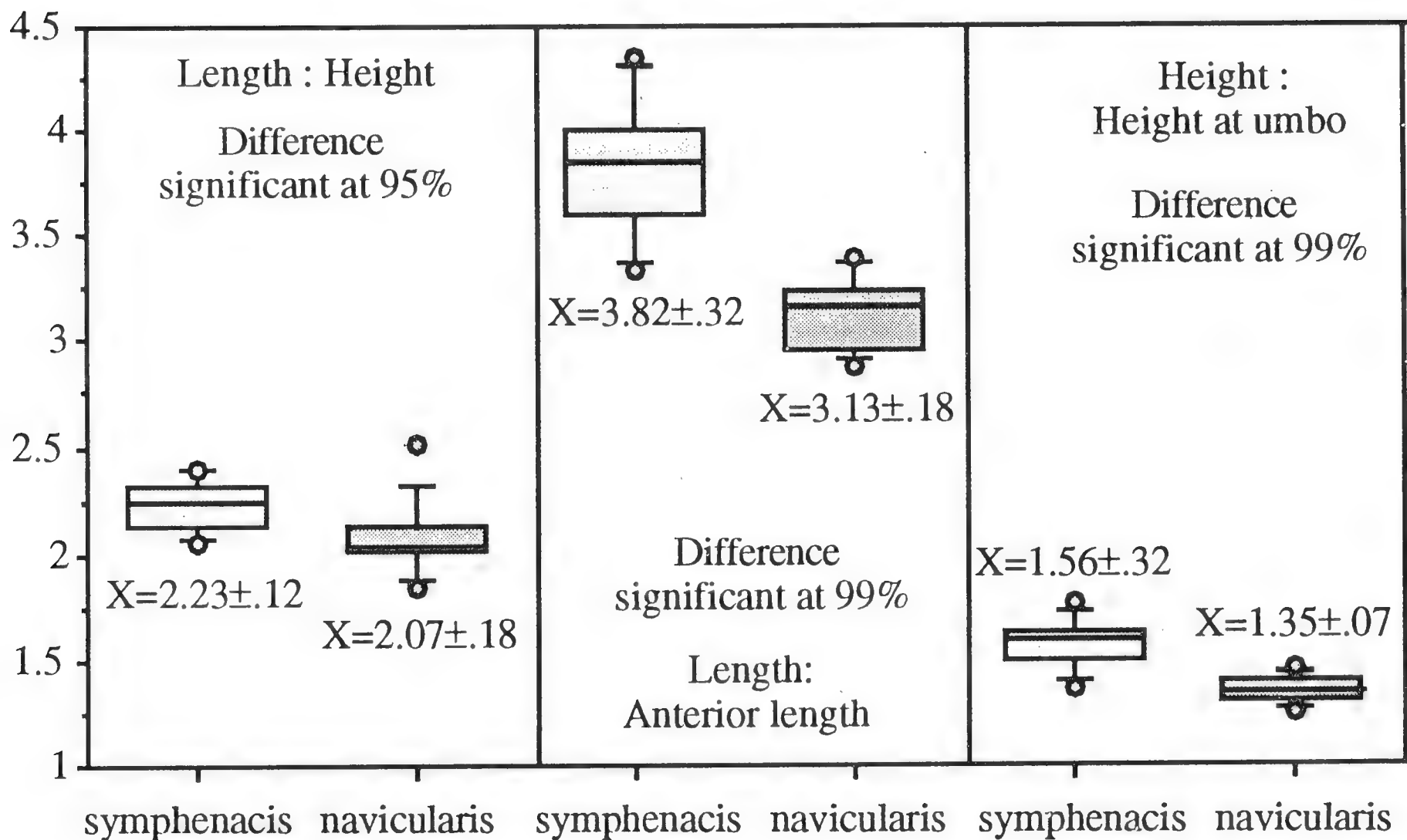


Fig. 2. Box plots of three morphometric ratios comparing aspects of the shapes of *Arca symphenacis* and *A. navicularis*.

### Subgenus *Tetrarca* Nordseick, 1969

Type species: *Arca tetragona* Poli, 1795

*Arca (Tetrarca) acuminata dayi* n. ssp.

#### Material

**Holotype:** NMW. Z. 1993.003.03 1 valve, Urf, Masirah, Oman, 20°12'N 58°42'E, Strandline, coll. Martyn. Day, 14. v. 1993.

**Paratypes:** NMW. Z. 1993.003.04, OMNH and ZMA, as holotype.

**Other material examined:** 3v, 18. iii. 1993; 13v, 10. ii. 1993; 1sh + 13v, 5. iv. 1993; 3v, 30. v. 1993; 3v, 17. vi. 1993, all from Urf, Masirah, 20°12'N 58°42'E, Strandline, coll. M. Day. 2v, 17. vi. 1993; 1v, 28. v. 1993, both from Haql, Masirah, 20°21'N 58°48'E, Strandline, coll. M. Day. 1v, Al Humr-Maghila, Masirah, 20°27'N 58°51'E, Strandline, coll. M. Day, 13. v. 1993. 1v, Nughut, Ras Radum, Masirah, 20°25'N 58°49.5'E, Strandline, coll. M. Day, 31. iii. 1993.

**Description:** Shell to 27 mm in length. Not thick but brittle, inflated; Length: Tumidity ratio (single valve) =  $3.34 \pm 0.35$ . Equivalve. Inequilateral, beaks in the anterior quarter or third, Length: Anterior length ratio =  $4.42 \pm 0.86$ . Outline subtrapezoidal, frequently irregular due to nestling habit in confined crevices, generally much longer than high Length: Height ratio =  $2.25 \pm 0.35$ . Posterior margin straight, obliquely truncate, posterior ventral margin acute, ventral margin long, gently curved but irregular with a variable but usually large byssal gape, anterior margin narrower than posterior, rounded. Dorsal margin long and straight, umbos very widely separated. Posterior carina acute, posterior area distinct, median area without a sinus but usually worn. Sculpture of numerous finely imbricate radial riblets except on posterior area where 3–5 weakly nodulose ribs are present. Dark periostracal hairs present with larger bristles inserted in a single row along the posterior carina. Hinge long straight, anterior set of teeth to 12 in number, posterior to 15 in number,



Measurements

Length in mm	Height	Tumidity (single valve)	Anterior Length	Length in mm	Height	Tumidity (single valve)	Anterior Length
<sup>H</sup> 22.1	8.1	7.6	4.4	13.7	5.4	4.1	2.9
24.6	13.9	8.4	5.2	14.5	6.4	4.4	3.7
26.6	13.1	8.5	5.5	11.1	5.1	2.9	2.5
22.5	11.8	8.0	3.9	10.8	4.1	2.5	3.5
17.7	8.3	6.0	3.4	10.2	4.8	3.1	2.2
18.3	9.3	5.8	4.4	10.7	3.4	3.0	2.9
20.4	10.0	6.0	5.5	10.6	4.2	2.7	3.0
19.7	9.2	6.3	3.0	9.5	4.0	2.5	2.8
8.8	5.0	2.7	1.9	7.9	3.6	2.2	2.0
8.8	3.5	2.8	2.5	24.8	11.8	8.2	5.0

no edentulous space, teeth becoming oblique at margins. ligament on a wide flat area, initially as two separate bands diverging from umbos and later filling in and extending over the dorsal area. Adductor scars subequal, posterior a little larger with a prominent myophoric flange extending into the umbo. External colour white mottled brown; internally white with brown on adductor areas.

*Derivation of name: dayi*: named for Martyn Day who collected the type series as well as an important series of bivalves from Masirah which are now housed in the National Museum of Wales.

*Distribution*: Known only from the east coast of Masirah, Oman.

*Remarks*: *Arca acuminata dayi* is clearly closely allied to the Mediterranean *Arca tetragona* Poli, 1795 (Oliver & von Cosel 1992) which is the type species of the subgenus *Tetrarca*. Indeed the similarity is such that it is extremely difficult to tell the two apart and the only difference that

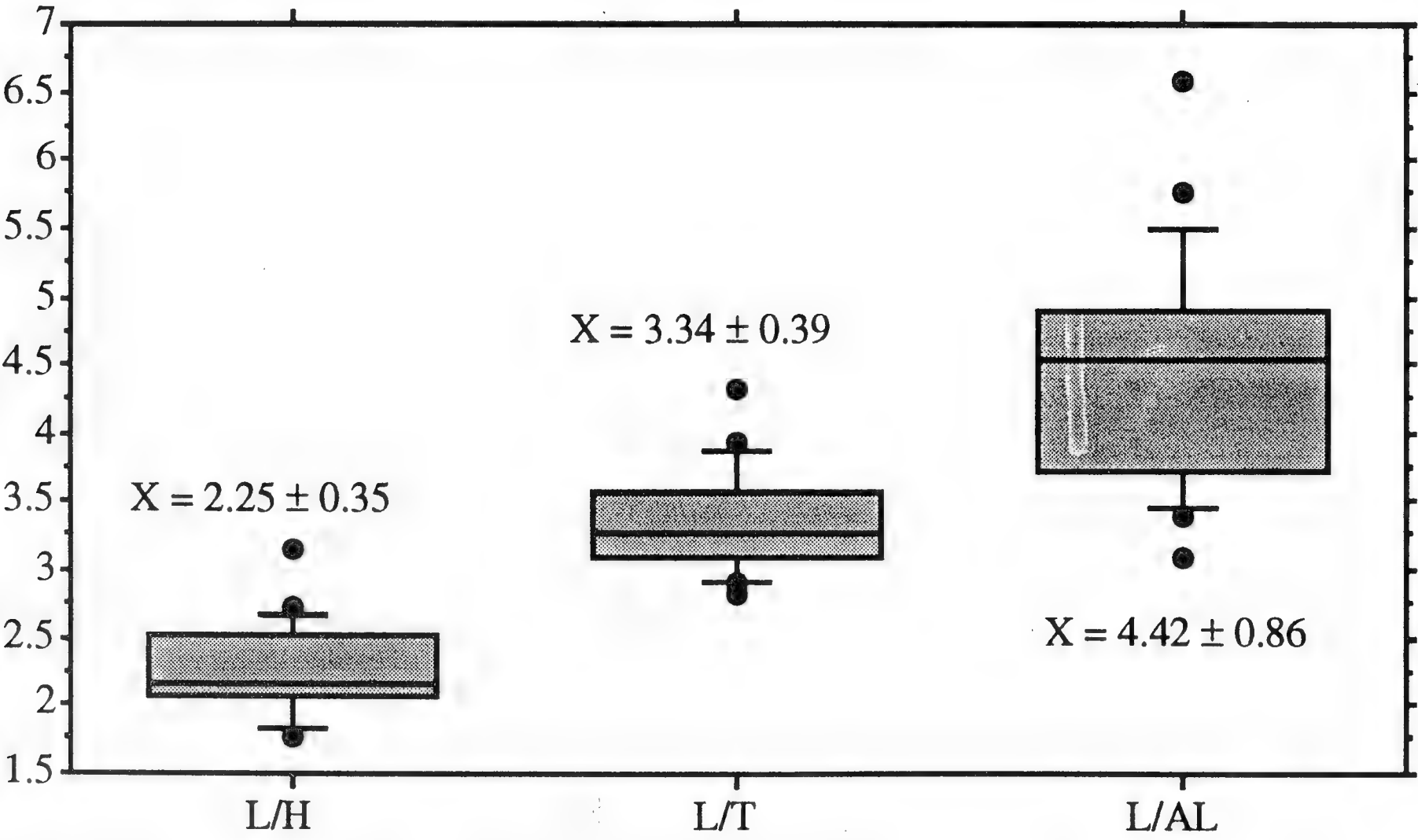


Fig. 3. *Arca (Tetrarca) acuminata dayi* n. subsp. Box plots of the ranges of the ratios Length to Height (L/H), Length to Tumidity (L/T) and Length to Anterior Length (L/AL) with means.

we can find is the more delicate radial sculpture (Plate 1). Our initial reaction to the Masirahn material was to give it species rank but before doing so we felt it necessary to check the South African fauna for any relatives (see *Barbatia perinesa* for a similar situation). In all of the 20th century literature only one species of *Arca* has been recorded from the warm temperate areas of South Africa, namely *Arca avellana* under a variety of now synonymised names. One variety still has common usage and is reported in Kilburn & Rippey (1982) as var. *acuminata* Krauss, 1848. On examination of the type figures (types lost from Stuttgart in 1939–45 war, see van Bruggen 1992) and material in collections it was immediately apparent that var. *acuminata* was not the same species as *Arca avellana* but was indeed part of the *Arca tetragona* group in that it possessed a myophoric flange and the peculiar split ligament. As with the subspecies *dayi* the distinction between *acuminata* and *tetragona* in minor (Plate 1) and one can only mention slight sculptural differences on the posterior ribs. On morphological grounds alone it could be argued that *tetragona*, *acuminata* and *dayi* represent a single species and that separation is done only on the grounds that the populations are geographically isolated. The same could be said for *Arca noae*, *zebra* and *pacifica* from the Mediterranean, Caribbean and East Pacific respectively or for *Arca avellana*, *imbricata* and *mutabilis* from the Indo-Pacific, Caribbean and East Pacific respectively. Connection between the Arabian Sea and the Mediterranean is highly unlikely for a species which prefers non tropical conditions but it may just be possible for the South African connection to be maintained via cold deep water currents. For this reason we have retained the Indian Ocean material as a separate species with South African and Masirahn subspecies based only on geographical grounds.

### Genus *Barbatia* Gray, 1842

*Arca barbata* Linnaeus, 1758

#### *Barbatia perinesa* n. sp.

#### Material

*Holotype*: NMW. Z. 1993.003.05 A single left valve labelled Muscat, Oman from D. Bosch coll.

*Paratypes*: NMW. Z. 1993.003.06, OMNH and ZMA.

*Other material examined*: 10v, 10. ii. 93; 3v, 17. vi. 93; 2v, 30. v. 93; 2v, 5. iv. 93; 8v, 14. v. 93, all from Urf, Masirah, 20°12'N 58°42'E, Strandline, coll. M. Day. 6v, Haql, Masirah, 20°21'N 58°48'E, Strandline, coll. M. Day, 17. vi. 93. 6sh, labelled Charbar & Karachi ex. Townsend in Melvill-Tomlin Coll.

*Description*: Shell to 21.5 mm in length. Not thick but brittle, not inflated; Length: Tumidity ratio (both valves) = 2.25: 1±0.15. Equivalve. Inequilateral, beaks in the anterior third, Length: Anterior Length ratio = 3.27: 1±0.25. Outline subrectangular a little irregular, much longer than high; Length : Height ratio = 1.96 : 1±0.07. Posterior margin obliquely truncate, posterior ventral margin roundly subacute, ventral margin long more or less straight except for slight byssal sinus, anterior margin generally broader than posterior, rounded to subtruncate. Dorsal margin long and straight, umbos widely separated. Posterior carina rounded but posterior area distinct, median area slightly flattened but median sinus not developed. Sculpture of numerous radial riblets except on posterior area where 5–7 ribs are present. Every 4–5 riblets interrupted by a radial groove, grooves numbering up to 21 in the holotype. The radial grooves are not developed in shells under 12 mm long. Hinge long very gently curved, anterior set of teeth shorter than posterior; 17/28 in

*Measurements*

Length in mm	Height	Tumidity (single valve)	Anterior Length	Radial Groove number
<sup>H</sup> 21.5	10.3	5.1	6.1	21
21.1	10.7	4.9	6.5	worn
18.9	10.0	4.5	5.2	worn
18.9	10.2	4.3	5.7	18
18.3	9.3	4.2	5.5	20
18.6	9.2	4.2	5.6	19
13.5	7.0	2.9	4.2	14
12.0	5.7	2.6	3.7	worn
12.8	6.5	2.7	3.6	worn
14.0	7.4	3.2	3.8	17
14.3	7.8	3.2	4.3	17
<sup>K</sup> 10.0	5.1	2.3	3.0	not developed
<sup>K</sup> 11.9	6.0	2.8	3.5	not developed
<sup>K</sup> 9.2	4.8	1.8	3.1	not developed
<sup>K</sup> 8.9	4.5	1.9	3.1	not developed
<sup>K</sup> 8.1	4.0	1.6	2.8	not developed
<sup>K</sup> 7.1	3.7	1.5	2.5	not developed

<sup>H</sup> Holotype: <sup>K</sup> Specimens from Charbar/Karachi

holotype, no edentulous space. Ligament on a wide slightly cleft area, initially on posterior only but later filling all dorsal area except for a small anterior zone below the beaks. Adductor scars subequal, posterior a little larger; radial pallial scars prominent. External colour white with beige-brown zones and patches these consistently forming bars down the posterior carina; internally white suffused with violet at least around the posterior ventral margin.

*Derivation of name:* *perinesa* from the Greek, *perinesos* to mean purple edged and referring here to the internal colouration of the shell.

*Distribution:* Muscat, but no detail is recorded, for the type series which are all isolated beached valves. Small live collected specimens in the Townsend material given to Melvill and labelled "Arca, dredged Charbar & Karachi" are the same species. It has recently been commonly found on the strandline on the south east coast of Masirah by Martyn Day. The total range would therefore appear to be, Oman and Mekran Coast.

*Remarks:* *Barbatia perinesa* is unusual for tropical Indo-Pacific species in having the following combination of characters: not greatly inequilateral, presence of radial grooves indicating isolated rows of specialised periostracal bristles, a wide dorsal area and a long anterior set of hinge teeth. The species belonging to the group of *B. foliata* have a uniform riblet arrangement and evenly sized periostracal bristles. The group of *B. setigera* have radial grooves but the anterior area is greatly shortened and the dorsal area very narrow. The group of *B. fusca* have uniform radial riblets. The only species to share these characters are the Mediterranean *B. barbata* L., the West African *B. gabonensis* Oliver & Cosel, the southern Australian *B. pistachia* Lk. and the South African Cape species *B. sculpturata* Turton. Of these *B. perinesa* and *B. sculpturata* are clearly closely related. In *B. sculpturata* the ligament remains in a posterior position; there is an edentulous gap in the hinge at all sizes, the outline is less inequilateral, and less quadrate, and the interior colour is pink (Kilburn 1972). Kilburn (1983) states that *B. sculpturata* is restricted to the Cape and Transkei regions of South Africa and is absent from subtropical waters. The isolation of *B. sculpturata* and *B. perinesa* further validates the treatment of these forms at the species level.



**Genus *Acar* Gray, 1857**

*Arca gradata* Broderip & Sowerby, 1829

***Acar abdita* n. sp.**

*Material*

*Holotype*: NMW. Z. 1993.005.07, one complete specimen from under rocks at top of shore close to sand, adjacent to Muscat Aquarium, Al Bustan, Oman, 23°33.5'N 58°37.5'E, coll. P. G. Oliver/H. C. G. Chesney, 26. x. 1992.

*Paratypes*: NMW. Z. 1993.005.08, OMNH and ZMA as holotype.

*Other material examined*: 10 spec, Seifa, [Muscat-Ras al Hadd], Oman, 23°25'N 58°46.5'E, Under large boulders embedded in gravel at upper shore above *Saccostrea* level, coll. P. G. Oliver/H. C. G. Chesney, 19. xi. 1992.

*Description*

Shell (Plate 2) to 10 mm in length. Prodissoconch (Plate 2) with a weak rim, 380  $\mu$ m in diam. Not tumid, Length to tumidity (both valves) ratio 1.90:  $1 \pm 0.15$ . Equivalve. Distinctly inequilateral, beaks towards the anterior, Length to anterior length ratio = 3.52 :  $1 \pm 0.41$ . Outline variable quadrate to subtrapezoidal, Length to height ratio 1.84 :  $1 \pm 0.16$ . Posterior margin obliquely truncate to rounded subtruncate, more expanded than anterior; posterior ventral junction narrowly rounded or acute depending on wear. Anterior rounded, ventral margin long, weakly sinuate due to small byssal gape. Dorsal margin long, straight, umbos low, dorsal area narrow. Sculpture primarily of radial ribs but interrupted by a strong concentric element resulting in the formation of nodules at their intersection and in some strong spines along the posterior carina. Radial ribs at 5 mm from umbo range in number from 31–40 with an average of 35. Posterior area demarcated by an angular carina and bearing 5–7 divaricate ribs. Hinge long on a gentle curve and teeth in two series but lacking an edentulous space. Teeth number in holotype; 7 in anterior set, 13 in posterior. Ligament restricted to behind the beaks and developing up to 5 chevrons. Adductor scars subequal, posterior a little larger; both slightly raised. Inner margin weakly crenulate often obscure except posteriorly. External colour dirty white, internally white rarely tinged with beige.

*Derivation of name*: *abdita*, from the Latin *abditus* to mean hidden/secret and referring to the fact that this species has gone unnoticed probably because of its size and unlikely habitat.

*Distribution*: Currently only known from a short stretch of the Oman coast from Seifa to Muscat (either side of 23.5°N) but may well be widespread in the Indian Ocean.

*Habitat*: Lives attached by a weak byssus to the undersides of large rocks embedded in sandy gravel in the upper littoral zone. Here it lives in association with *Barbatia decussata* and *Brachidontes* sp.

*Remarks*: Like Kilburn (1983) before us we are surprised at the discovery of a new species of *Acar*. This is due to the widespread confusion in taxonomy and nomenclature of the ubiquitous and rather variable *A. plicata*. It is likely, but for the unusual habitat, that we would not have examined these small shells closely but the distinctions are clear. The sculpture is finer (Fig. 4), dominated by the radial element rather than the concentric; the outline is less inequilateral (Fig. 4); and the prodissoconch is weakly capped and approximately 2 times larger (380  $\mu$ m as compared to 180  $\mu$ m). In Oman and the Arabian Gulf *A. plicata* is invariably tinged a salmon pink and in the field is quite distinct from the dirty white of *A. abdita*.

The *A. plicata* group includes *A. botanica* Hedley and *A. iota* Iredale and in both the sculpture is more coarse. Kilburn (1983) described two endemic species to South Africa, both with capped prodissoconchs but they are primarily sublittoral in distribution. *Acar petasion* is known from the littoral but Kilburn emphasises the large edentulous gap in the hinge at all sizes of shell. This contrasts with *A. abdita* which never has an edentulous gap. In *A. agulhasensis* the posterior ribs are scarcely divaricate and resemble the situation in

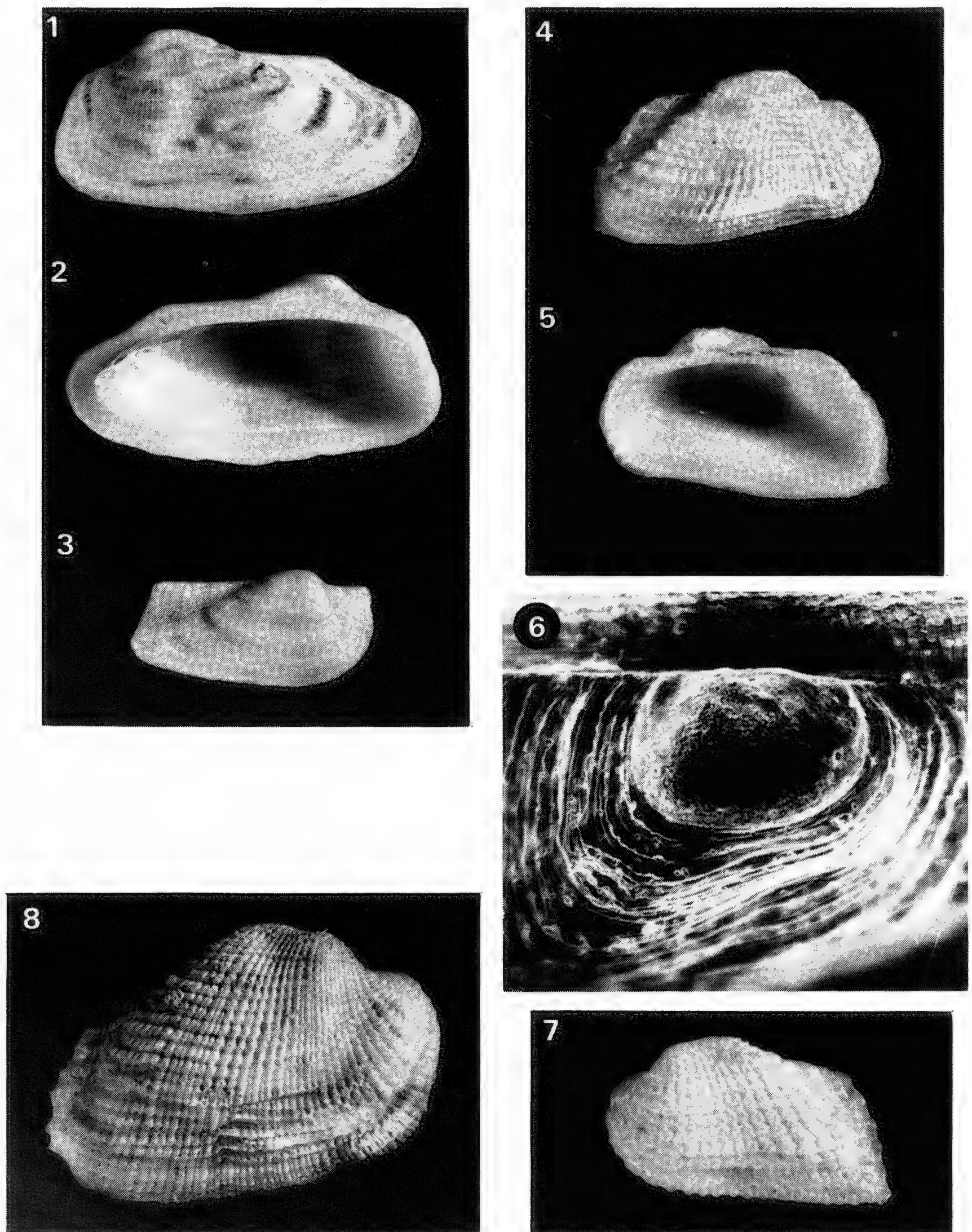


PLATE 2

Figures 1-2. *Barbatia perinesa* n. sp. Holotype. NMW.Z.1993.003.05. Length = 21.5 mm.  
 Figures 3. *Barbatia perinesa* n. sp. Charbar/Karachi. NMW.1955.158.1628. Length = 11.9 mm.  
 Figures 4-5. *Acar abdita* n. sp. Holotype. NMW.Z.1993.003.07. Length = 9.1 mm  
 Figures 6-7. *Acar plicata* Dillwyn. Al Bustan, Muscat, Oman. Lengths = 22.9 mm & 8.5 mm.  
 Figure 8. *Acar abdita* n. sp. Prodissoconch (= 380  $\mu$ m). NMW.Z.1993.003.08.



## Measurements

Length in mm	Height	Tumidity single valve	Anterior Length	Rib Number 5 mm from umbo	Posterior crenulation s
9.1	5.2	2.8	2.55	37	7
8.2	4.9	2.45	2.2	40	6
5.05	2.8	1.5	1.4	34	5
5.6	3.25	1.75	1.5	31	5
6.05	2.95	1.6	1.55	33	6
4.8	2.95	1.25	1.3	35	5
5.1	2.5	1.35	1.15	33	6
4.85	2.55	1.1	1.4	33	6
5.5	3	1.4	1.6	36	6
5.95	3.55	1.85	1.5	33	5
8.5	4.9	2.35	2.4	38	6
8	4	2.7	2.05	39	7
5.65	3.1	1.9	1.35	36	6
6.9	3.2	1.9	1.7	37	6

*A. sociella* Brookes (Norfolk Is) which is not the case for *A. abdita*. The combination of these differences and the upper littoral habitat of *A. abdita* are sufficient to give it separate status.

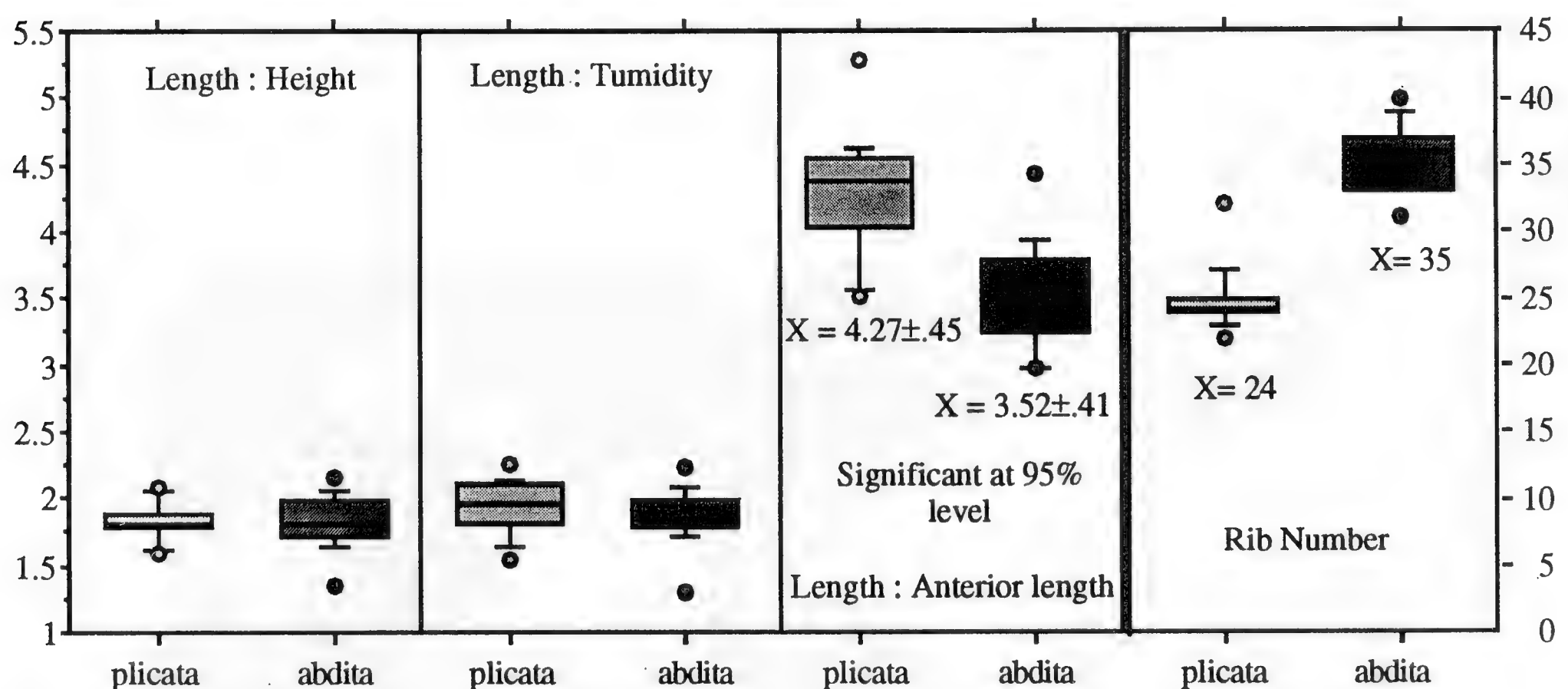


Fig. 4. Box plots of three morphometric ratios and rib number, comparing *Acar abdita* with *Acar plicata*.

 Genus *Anadara* Gray, 1847

Type species *Arca antiquata* Linnaeus, 1758

*Andara pesmatasis* n. sp.

*Anadara* sp. Biggs, 1969: 204.

## Material

*Holotype*: NMW. Z. 1993.003.09. One complete specimen, collected live from Masirah, Oman by Don Bosch.

*Paratypes*: NMW. Z. 1993.003.10. OMNH & ZMA. Beach worn valves from strandline in front of BERS camp, Ras Hilf, Masirah. 21°42'N 58°53'E, coll P. G. Oliver/H. C. G. Chesney, 23. xi. 1992.



*Other material examined:* 2v, Masirah, no precise locality, coll. D. Bosch. 2v, Haql, Masirah, 20°21'N 58°48'E, Strandline, coll. M. Day, 5. ii. 1993. 4v, 9. ii. 1993; 10+ v, 11. ii. 1993, both from 3 km south of Ras Qudūfah, Masirah, 20°39'N 58°54'E, Strandline, coll. M. Day.

*Description:* Shell to 60 mm in length, solid and heavy. Equivalve. Tumid. Mean length: tumidity ratio of 1.34 : 1. Inequilateral, beaks towards the anterior. Mean length: anterior length of 2.62 : 1. Outline subquadrate with prominent umbos, mean length to height ratio of 1.27 : 1; posterior margin truncate, posterior area demarcated by distinct angulation; ventral and anterior margins in a continuous curve. Dorsal area wide, slightly cleft and covered by ligament which has only a single outer chevron except in the largest shells where a second chevron may develop close to the hinge. Sculpture of 18–20, usually 20, radial ribs; these are narrow on the posterior area but rather wide, deeply incised and with vertical sides on the median and anterior areas. Median ribs with closely spaced, rather irregular cross ridges; interspaces with widely spaced concentric striations. Periostracum unfortunately removed or worn from all available specimens. Hinge taxodont with numerous small mostly vertical teeth, holotype with 34 teeth in anterior set and 36 in posterior. Inner margin deeply crenulate with interlocking rectangular rib endings. Colour of shell, white.

*Derivation of name:* *psmatacis*, from the Greek *psmatakos* meaning anything that is spread out and relating to the widely spaced nature of the ribs.

*Distribution:* From Masirah only.

*Remarks:* This species was first recognised by Biggs (1969) who likened it to *A. antiquata*. That species differs considerably in outline, has over thirty ribs of which the anterior few are

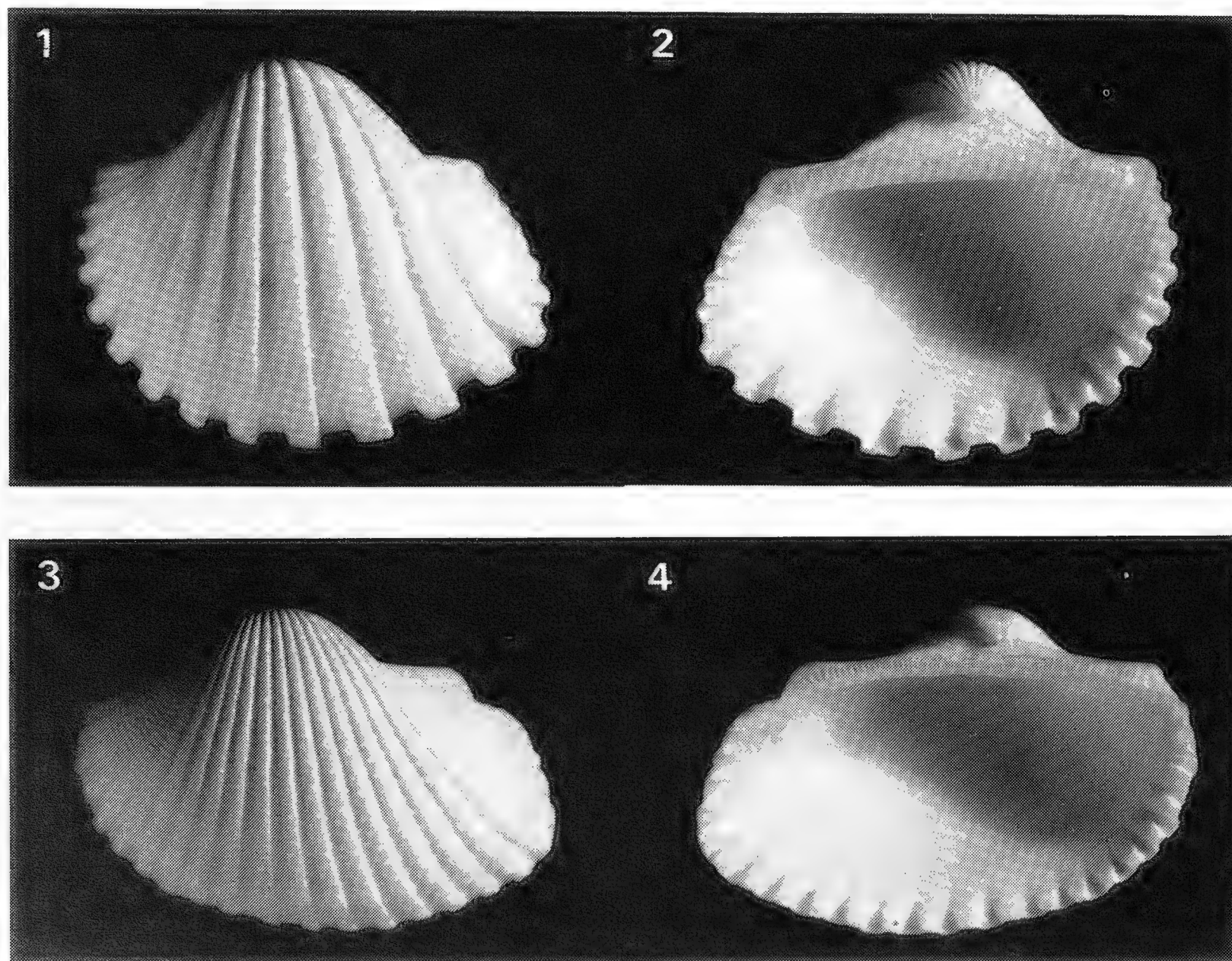


PLATE 3

Figures 1–2. *Anadara psmatacis* n. sp. Holotype. NMW.Z.1993.003.09. Length = 49.9 mm  
Figures 3–4. *Anadara ehrenbergi* Dunker. Muscat. Length = 50.5 mm.

Measurements

Length in mm	Height	Tumidity (single valve)	Anterior Length	Chevron Number	Rib Number
52.1	39.4	18.7	19.9	2	20
51.9	41.4	20.9	20.1	●	20
51.0	39.3	19.4	18.9	1	20
40.3	32.7	15.9	15.6	1	19
34.9	27.5	12.3	13.5	1	20
32.6	25.6	11.6	12.5	1	18
58.0	45.0	22.9	21.5	2	19
60.8	48.6	24.1	23.4	2	20
32.7	25.2	11.7	12.4	1	20
34.0	26.2	12.5	13.5	1	19
39.7	30.4	14.6	14.8	1	20
43.6	34.3	16.1	16.8	1	20
46.5	36.8	17.2	16.7	1	20
39.2	31.8	14.4	15.5	1	20
<sup>H</sup> 50.4	42.5	21.2	19.9	1	20

bisected. Specimens of *A. pesmatacis* identified by Kathleen Smythe and Don Bosch as *Larkinea rhomboidea* were found in the collection of the Oman Natural History Museum. *L. rhomboidea* species differs markedly in the number of ribs, sculpture on the ribs, overall shape and ligament. Furthermore it is not known west of Ceylon. *Anadara pesmatacis* is however much closer to the Red Sea/Arabian Gulf species *A. ehrenbergi*. It shares with that species the approximate outline, undivided heavy ribs and late onset of multiple chevrons in the ligament. *Anadara ehrenbergi* has a rib number with a modal value of 25 whereas *A. pesmatacis* has a modal value of 20 (Fig. 5).

*Anadara ehrenbergi* is narrower and less tumid but the relative position of the beaks is much the same. Comparative data is presented in Fig. 6.

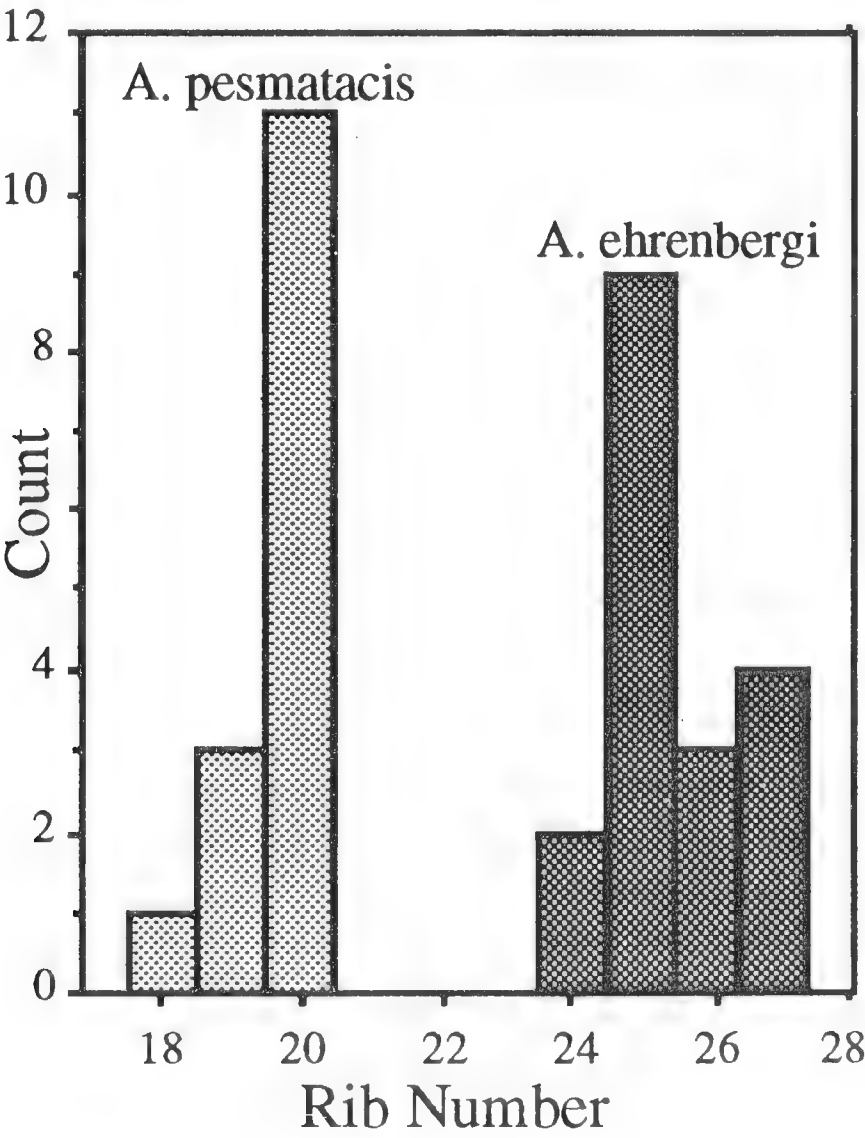


Fig. 5. Bar chart showing the frequency distributions of rib number for *Anadara pesmatacis* and *A. ehrenbergi*.

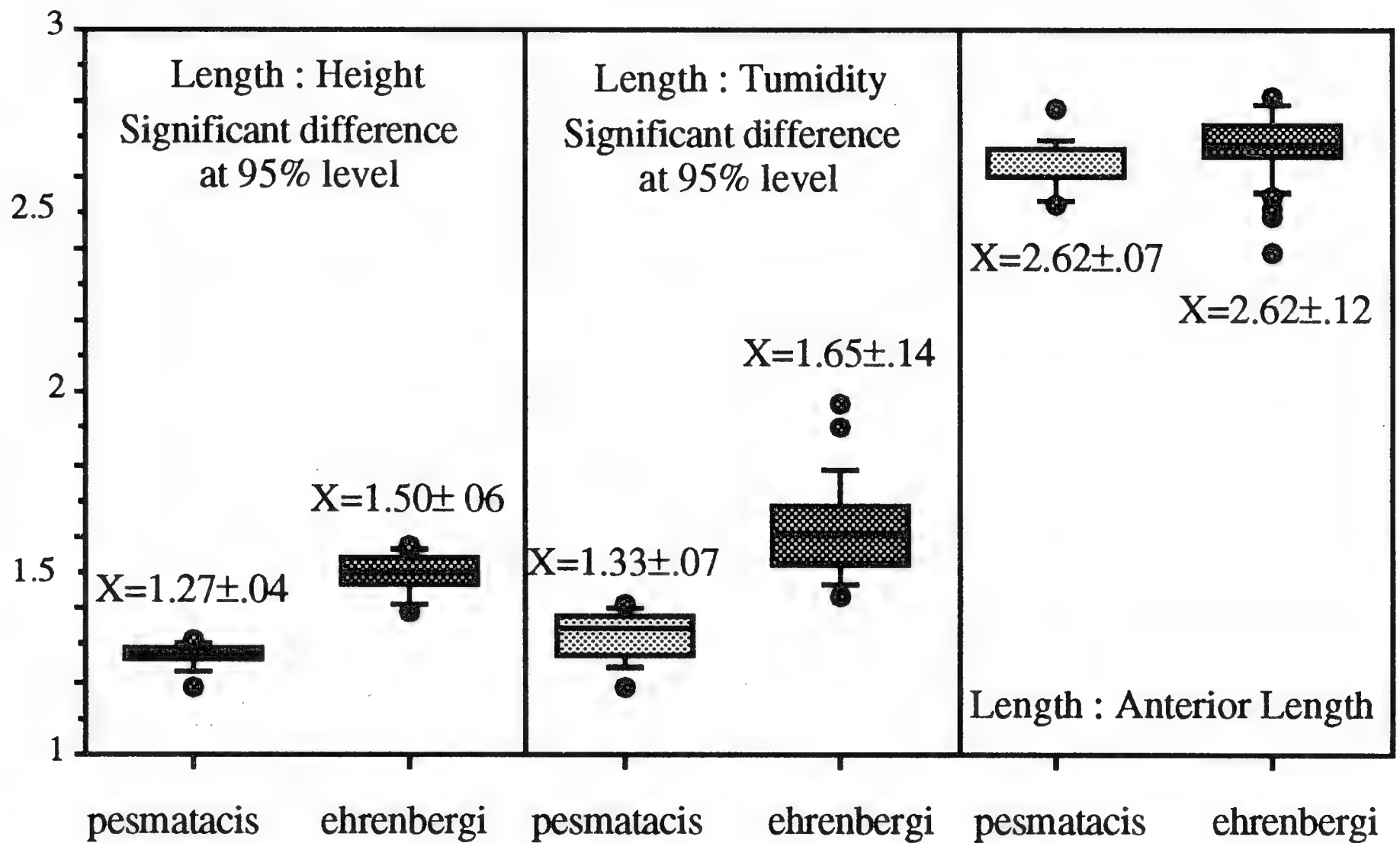


Fig. 6. Box plots of three morphometric ratios comparing aspects of the shapes of *Anadara pesmatacis* and *Anadara ehrenbergi*.

The question that must be posed is the possibility that *A. pesmatacis* is no more than an ecophenotype of *A. ehrenbergi*. *Anadara ehrenbergi* has not been found around Masirah but is known from the Gulf of Aden and Muscat, that is either side of *A. pesmatacis*. To date we have no material that is intermediate between the two and morphologically they are sufficiently distinct to be easily recognisable. Most species of *Anadara* share a similar habit in being poor shallow burrowers in sand and muds. One might then expect all species to show some ecophenotypic variation but this is not observed in species such as *Anadara natalensis* or *Anadara uropigimelana*. Consequently we feel satisfied that *A. pesmatacis* is a distinct species.

#### Family Noetiidae

#### Genus *Noetiella* Thiele & Jaeckel, 1931

Type species *Noetiella congoensis* Thiele & Jaeckel, 1931

#### *Noetiella chesneyi* new name.

*Arca pentunculiformis* var. *minor* Pallary, 1939: 125–126, fig. 14.

*Noetiella* (*Noetiella*) *minor* Pallary : Oliver, 1987: 268–269, figs 7–9.

Following the 1987 paper it was pointed out to us, by Philippe Bouchet, that the name *minor* was preoccupied by *Arca minor* Hagenow, 1842. This distinctive species, which is restricted to Kuwait and the Shatt el Arab, therefore requires a new name. We have taken this opportunity to name it after the Irish explorer and surveyor, General Francis Rawdon Chesney, who navigated the Euphrates river in 1835–37 (Guest 1992).

#### ACKNOWLEDGEMENTS

We would like to thank Don and Eloise Bosch, Peter Dance and Martyn Day for the use of their collections and Michael Gallagher for access to the collections in the Oman Natural



History Museum. Also Kevin Thomas of the National Museum of Wales for the photography.

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## INSTITUTIONAL ABBREVIATIONS

NMW National Museum of Wales before 1970  
NMW.Z National Museum of Wales. Zoology after 1970  
OMNH Oman Natural History Museum  
ZMA Zoological Museum, Amsterdam



# TAXONOMY OF ARABIAN BIVALVES PART 2. A NEW SPECIES OF *SEMELE* (BIVALVIA : TELLINOIDEA)

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(Accepted for publication, February 19th 1994)

*Abstract:* A new species of the bivalve genus *Semele* is described from the cold water upwelling area of the southern coast of Oman. Its close similarity to Eastern Pacific forms is further evidence of Tethyan relicts on the Oman coast.

*Key words:* Taxonomy, Bivalvia, Tellinoidea, Arabian Sea.

## INTRODUCTION

This paper is the second in a series describing and revising the taxonomy of bivalves from the Arabian Sea and Arabian Gulf in preparation of a compendium on the molluscan fauna of the region, organised by Dr Don Bosch.

## TAXONOMY

### Superfamily Tellinoidea

### Family Semelidae

### Genus *Semele* Stoliczka, 1870

Type species: *Semele reticulata* Schumacher, 1817

### *Semele zalosa* n. sp.

*Semele scabra* Hanley : Bosch & Bosch, 1982: 183.

#### *Material*

*Holotype:* NMW. Z. 1993.005.01 One shell, from Sur Masirah, Masirah Island, South coast of the Sultanate of Oman. 20°26'N 58°43'E. Coll. S. P. Dance 20. xi. 91.

*Paratypes:* NMW.Z. 1993.005.02 1 shell, West Horn Reef, Masirah, 21°42'N 58°53'E, coll. H. C. G. Chesney/P. G. Oliver, 24. x. 1992. NMW.Z. 1993.005.03 1 shell, Masirah, no precise locality, coll. D. Bosch. ZMA, OMNH & USNM 5 shells, Masirah, no precise locality, coll. D. Bosch.

*Other material examined:* 3 shells, Masirah, no precise locality: 20°N 58°E, coll. K. Smythe, 4 shells, No exact locality, part of Don Bosch's general collection from Oman. 1 shell, BERS

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Camp, Masirah, 21°42'N 58°53'E, coll. M. Day, 7. i. 1993. 2v, Umm Rusays, Masirah, 20°29'N 58°47'E, coll. S. P. Dance, 21. xi. 1991. 9v, 3 km S of Ras Qudūfah, Masirah, 20°39'N 58°54'E, coll. M. Day, 11. ii. 1993. 4v, 3 km S of Ras Day, 5. iii. 93. 1v, Ras abu Rasas, Masirah, 20°10'N 58°38'E, coll. M. Day, 18. ii. 93. Specimens in the Oman Natural History Museum from Masirah. Ras Jibsh, 21°25'N 59°25'E. Wahibah Sands, 21°13'N 59°00'E. As Sultyat, 20°18'N 57°50'E. Ras Mardakah, 19°00'N 57°50'E. Raysut, 16°55'N 54°00'E.

*Description:* To 77 mm. Compressed (L/T ratio = 2.32: 1, Fig. 1) Very slightly inequivalve, LV a little flatter. Equilateral. Outline discoid (L/H ratio = 1.06: 1, Fig. 1) with a slight posterior flexure, escutcheon margin straight, lunule margin concave, anterior broadly rounded, posterior a little truncated. Lunule asymmetric, small, impressed narrowly cordate. Escutcheon rather narrow, cleft near beaks, flatter posteriorly. External ligament a narrow band extending about 1/3 of escutcheon, internal ligament large in a narrow, elongate posteriorly directed resilifer. RV with two cardinal teeth, posterior persistent, anterior soon eroded; anterior and posterior laterals submarginal: LV with posterior cardinal soon eroded; laterals marginal. Sculpture, to about 30 mm, smooth with dense radial striae; then progressively developing roundly rugose concentric ridges; the surface over the ridges may appear minutely pustulose or chalky. Pallial sinus large extending to below beaks, rounded and slightly ascending, never confluent with pallial line; inner margin smooth. White with a greyish brown periostracum except for pink tracery over escutcheon and lunule, hinge plate also with some pink colouring.

Measurements

Length mm	Height mm	Tumidity mm
H49.2	45.4	21.0
65.4	63.1	30.7
66.0	62.8	29.5
44.2	41.9	18.8
46.1	43.4	20.8
45.2	44.0	20.7
63.3	60.0	27.7
22.2	20.5	7.8
54.6	50.6	24.7

H = Holotype

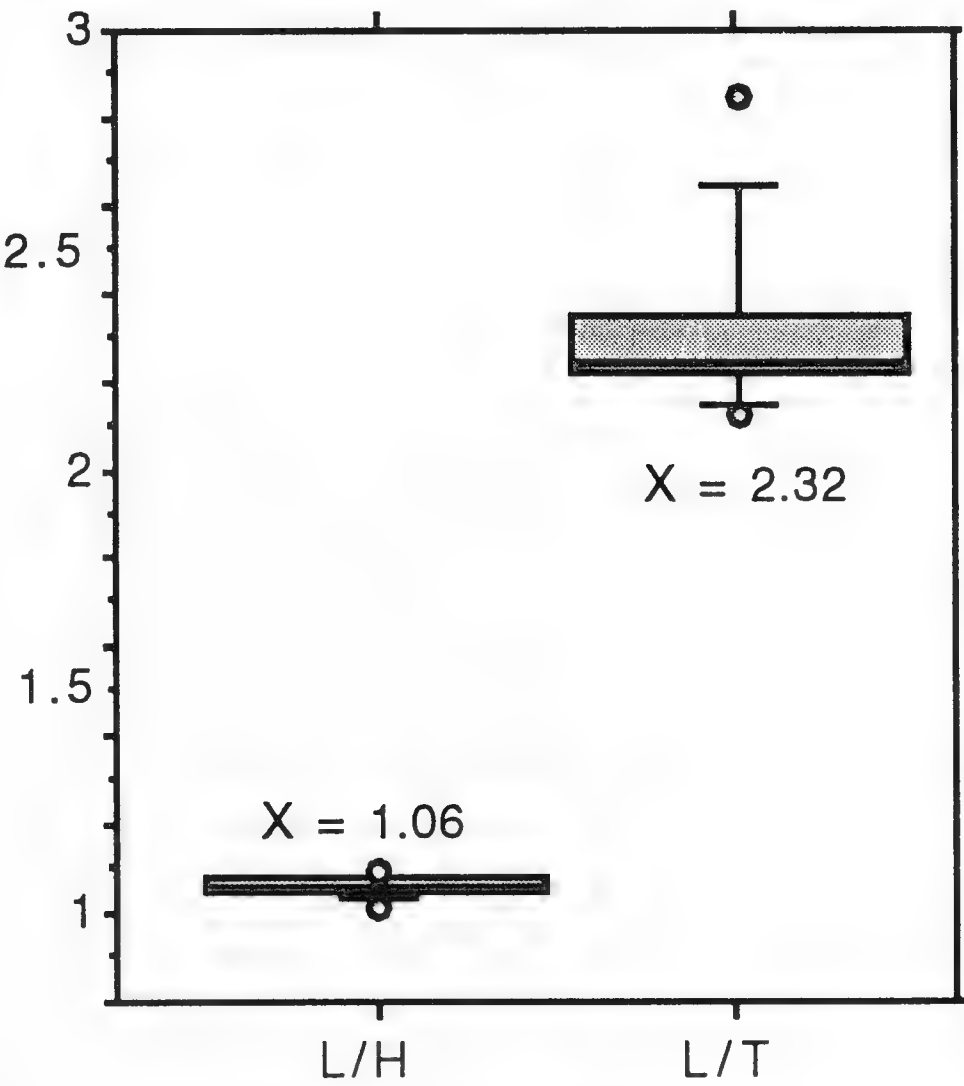


Fig. 1. *Semele zalosa* n. sp. Box plots of the ratios Length to Height (L/H) and Length to Tumidity (L/T) with means.

*Derivation of name:* *zalosa* from *zale* Gr. meaning the surging sea and referring to the wave like pattern of the sculpture and the fact that it has only been found washed on shore by storms.

*Distribution:* Raysut, Ras Madrakhah, As Sultiyat, Masirah, Wahibah Sands Coast and Ras al Jibsh. Ranging along southern coast of Oman from 16°55'N to 21°25'N but most commonly around Masirah at 20°30'N. We have been unable to confirm the presence of this

species in the Arabian Gulf despite citations of *S. scabra* in Glayzer *et al.* (1984) and Bosch & Bosch (1982).

*Remarks:* Bosch & Bosch (1982) applied the name *Semele scabra* Hanley, 1844 to this form. No type specimens are extant in the BM(NH) but Hanley's descriptions (1844, 1856) clearly state that his species has "short, thin crowded lamellae". Hanley (1856) also likens it to Reeve's figure 33 in his monograph on *Amphidesma* (Reeve 1853) and from this figure *S. scabra* can be seen to be a finely lamellate species bearing none of the wrinkled pustulose sculpture.

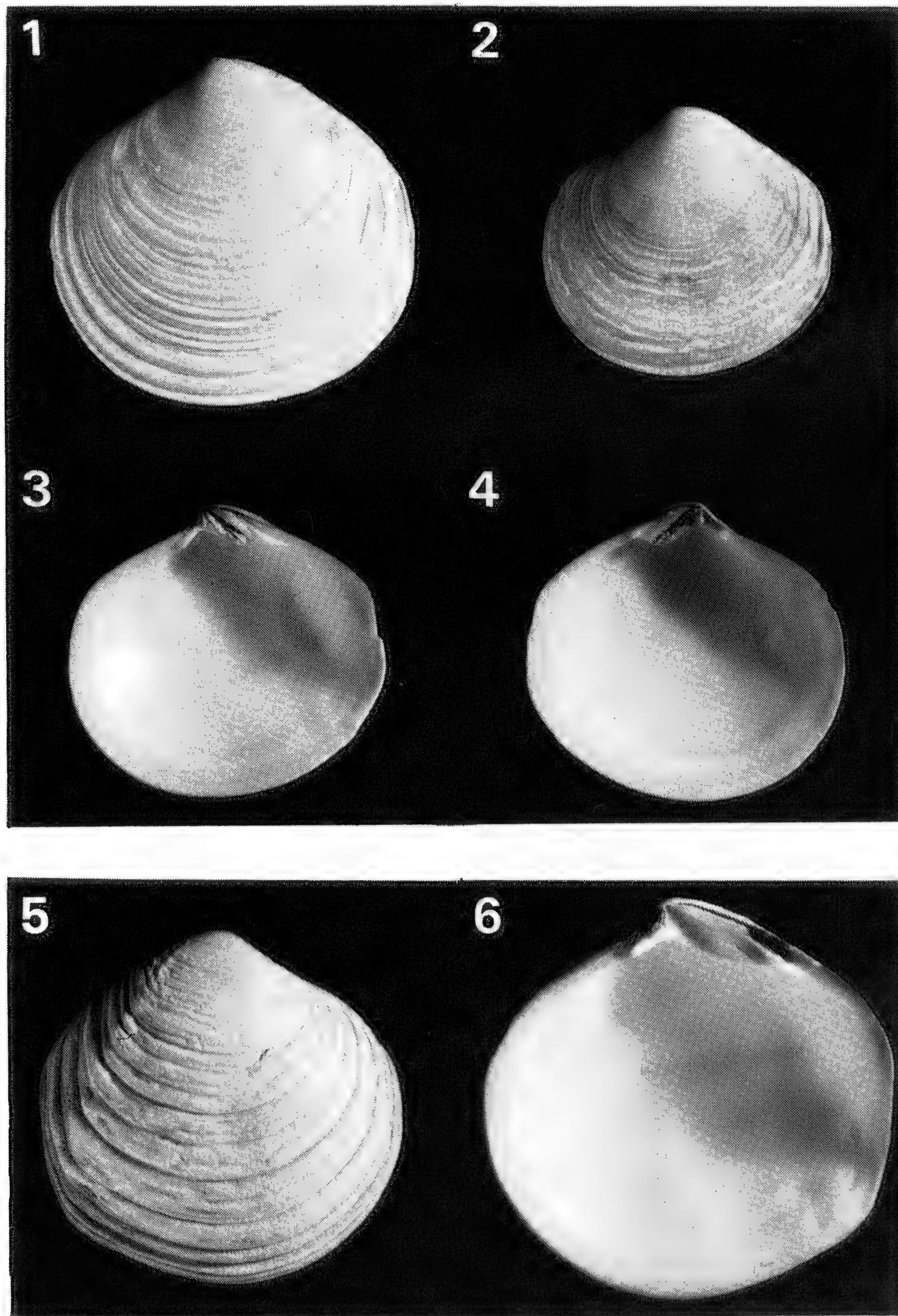


PLATE 1

Figure 1. *Semele zalosa* n. sp. Paratype. Masirah, Oman. NMW.Z. 1993.005.02. Masirah. Length = 61.2 mm

Figure 2-4. *Semele zalosa* n. sp. Holotype. Sur Masirah, Masirah, Oman. NMW.Z. 1993.005.01. Length = 49.2 mm

Figures 5-6. *Semele decisa* Conrad. California. Melvill-Tomlin Coll. NMW 1955.158.1602. Length = 74.8 mm

This wrinkled sculpture is however typical of a group of Panamic species represented by *S. decisa* (Conrad, 1837) and *S. sowerbyi* Tryon, 1869 (Coan 1988). Of these it is most closely allied to *S. decisa* from California but that species is larger, with a strong flexure causing a posterior sulcus. It has a macroscopic pustulose surface with the colouring more intensely pink to purple on the hinge plate and extending around margins. Given that the small shells lack the wrinkled corrugations other small smooth Indo-Pacific species have been checked. The most similar of these is *Semele simplex* Adams & Reeve, 1850 but it is a more elongate form and golden coloured within.

The similarity of *S. zalosa* to a Panamic group of species is on first appearances remarkable but this phenomenon has been observed for other species with a distribution restricted to the southern coast of Oman. Taylor & Smythe (1985) discuss the isolation of once pantropical groups through the splitting of the Tethyan ocean, by the closing of the Mediterranean and expansion of the Atlantic. In their example, *Trocheta*, isolation was enhanced by the preference of that genus for areas of cold upwelling. *Semele zalosa* is not restricted to the extreme of the south Arabian upwelling as it occurs commonly at Masirah and rarely farther north. The genus *Semele* is not restricted to any particular biotope and the *S. decisa* group, in the eastern Pacific, is not associated with upwelling areas. If the cold water of the immediate upwelling area is not the restrictive factor it is difficult to explain why *S. zalosa* has retained such a limited distribution. One can only surmise that the enhanced productivity associated with the upwelling has a wider effect and only gradually gives way to the typical low productivity tropical waters surrounding it. Some species may require the productivity regime but are not affected by the higher temperatures. The only species of *Semele* overlapping with *S. zalosa* is *S. sinensis* which has a typical pan Indo-Pacific range from east Africa to Japan. *Semele carnicolor*, a species with closely spaced crispate lamellae, is known from Aden and the Mussandam peninsula but does not apparently occur in the Dhofar-Masirah area.

#### INSTITUTIONAL ABBREVIATIONS

NMW National Museum of Wales before 1970

NMW.Z National Museum of Wales. Zoology after 1970

OMNH Oman Natural History Museum

ZMA Zoological Museum, Amsterdam

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# ON THE TAXONOMIC DISCRIMINATION BETWEEN *PATELLA ASPERA* RÖDING AND *P. CAERULEA* LINNAEUS (GASTROPODA: PATELLIDAE) USING CONCHOLOGICAL TRAITS

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**Abstract:** The taxonomic status of the gastropods *Patella aspera* Röding and *P. caerulea* Linnaeus has been a contentious issue for some time due to substantial overlap in the distribution of the conchological traits used for their classification. Although a number of conchological traits, when taken altogether, allow a separation of the two species, confirmation of their specific status had to wait until clear-cut differences were found in non-conchological traits. In fact, support for the validity of the two species has been provided by radular, karyotypic, electrophoretic, and soft-part studies. This may be due, at least in part, to difficulties involved in analyzing shell traits with overlapping variation. In this article we apply techniques of statistical mixture analysis to data on the shell height in the successive growth stages of *P. aspera* and *P. caerulea*. Our purpose is to illustrate the suitability of mixture analysis to handle situations in which single traits with overlapping variation are used for species discrimination. The results indicate that shell height provides a reliable criterion for species identification and may help improve our understanding of single trait variation in these *Patella* species. We suggest that mixture analysis can be used as a convenient tool for the extension of this work to other conchological traits and other taxa.

**Key words:** *Patella aspera*, *Patella caerulea*, taxonomic discrimination, mixture analysis.

## INTRODUCTION

*Patella aspera* Röding (= *P. ulyssiponensis* Gmelin) and *P. caerulea* Linnaeus are two very abundant European limpets. The first is found in the Mediterranean and is also widely distributed along eastern Atlantic coasts, whereas the second is restricted to the Mediterranean. The habitat of the two species is very similar. Both are found on hard substrates in the littoral zone and reach upper subtidal levels, although *P. aspera* has a lower distribution range in the littoral zone and shows a preference for areas exposed to wave action. From a taxonomic standpoint, *P. aspera* and *P. caerulea* are considered two separate species, although their specific status was a contentious issue in the past.

The difficulties for their classification arise from a substantial overlap in the distribution of the traits used for species discrimination in this genus, namely shell shape, ornamentation, and coloration. Some taxonomists interpreted this overlap as arising from interbreeding and accordingly rejected a specific distinction or considered this to be a case of incomplete speciation (Fischer-Piette 1935, 1938, Evans 1953, 1958). Others, however, argued that reproductive features (e.g., timing of the breeding season) could be used as a basis for discriminating between the two species (Fischer-Piette 1948). The controversy was

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finally settled when Fischer-Piette and Gaillard (1959) reported clear-cut species differences in the single cusp lateral teeth of the radula.

More recently, analyses of a variety of traits has confirmed the taxonomic validity of *Patella aspera* and *P. caerulea*. Such is the case with studies dealing with karyotypic (Cervella, Ramella, Robotti & Sella 1988), electrophoretic (Sella, Robotti & Biglione 1989, Cretella, Scillitani, Toscano, Turella & Picariello 1990), and soft-part traits (Cretella *et al.* 1990).

A perusal of the literature reveals that conchological traits, when taken altogether, allow for a separation of the two species. Indeed, several authors have relied on conchological traits to separate samples the species membership of which was later confirmed by differences in radular (Fischer-Piette & Gaillard 1959), electrophoretic (Cretella *et al.* 1990), or soft-part traits (Cretella *et al.* 1990). Nevertheless, taxonomists were reluctant to grant these *Patella* their current specific status until clear-cut differences were found in non-conchological traits. This may be partly due to the difficulties involved in analyzing shell traits with overlapping variation.

In this article we illustrate the use of mixture analysis to discriminate between *Patella aspera* and *P. caerulea*. Mixture analysis is a convenient statistical technique to handle situations in which traits with overlapping variation are used for species discrimination (Everitt & Hand 1981, Titterington, Smith & Makov 1985, Equihua 1988). In particular, mixture analysis appears to be appropriate for dealing with overlapping variation because it can be applied to data that are not classified (i.e. the correct species membership of a given specimen is unknown). The technique therefore circumvents the problem of specimens that fall in the region of overlap and cannot be unambiguously assigned to either species. The trait that we have selected to illustrate the use of mixture analysis is shell height. Our aim is twofold: 1) to encourage the use of mixture analysis as a potentially useful alternative to traditional methods of taxonomic data analysis, and 2) to improve our understanding of single trait variation in these species.

## MATERIALS AND METHODS

For this study, over a thousand specimens of *Patella aspera* and *P. caerulea* were obtained from the coast of Oropesa Cape (Castellón, España). Specimens of all available sizes were collected randomly in a narrow band of uniform characteristics located at the base of the littoral zone. Sampling took place in May 1989.

In the laboratory, shell length and height were measured to the nearest 0.05 mm using calipers on 1025 useful, whole shells. Specimens were also assigned to one or the other species based on non-conchological traits, mainly foot morphology and colour (Cretella *et al.* 1990). In our study site, *Patella aspera* is easily recognized by its pyriform or oval foot, with sole yellow or cream with no dark areas. *Patella caerulea*, on the other hand, has an oval foot, with sole dark grey or bluish with edge and centre cream. Use of these diagnostic characters resulted in 439 specimens being classified as *P. aspera* and 581 as *P. caerulea*. Five specimens could not be unambiguously assigned to either species and were classified as 'doubtful'. Finally, the shells were labelled and preserved together with the corresponding soft parts.

As a preliminary to the statistical analysis, the range of shell lengths in the total sample (5.30–35.10 mm) was divided into 31 intervals of 1 mm, which were operationally considered as growth stages. Subsequently, specimens were, irrespective of their species membership, grouped according to shell length. This resulted in 31 subsamples (i.e. shell-length class intervals) corresponding to the different growth stages that were then submitted to the statistical analysis. Only subsamples containing in excess of six data points were considered for the analysis. These included all shell-length class intervals between 7 and 26 mm.

Each subsample was considered a mixture of two components normally distributed as to shell height. The assumption of normality has wide theoretical support (Falconer 1989, Hartl & Clark 1989) and was tested using the Kolmogorov-Smirnov goodness of fit test with Lilliefors correction (Sokal & Rohlf 1981). The results of goodness of fit testing revealed no significant departures from normality ( $P > 0.05$ ) for most growth stages of the two species. Only three stages of *Patella aspera* (17–18 mm, 20–21 mm, and 21–22 mm) and two in *P. caerulea* (16–17 mm and 21–22 mm) were marginally significant at the 0.05 level.

Statistical analysis of each subsample required estimation of five parameters, including two means, two standard deviations, and one mixing parameter (proportion of either component in the mixture). The statistical technique used is a form of mixture analysis (Everitt & Hand 1981, Titterton *et al.* 1985, Equihua 1988) that follows a Bayesian approach (Box & Tiao 1973, Makov & Smith 1977). The algorithm for estimation of the parameters is based on the Restricted Bayesian Updating Method (Owen 1975) and has been described by Bermúdez & Sendra (1991). The algorithm assumes that the mixing parameter follows a beta distribution while the mean and the variance of each component in the mixture follow a normal-inverted gamma distribution. Data were entered into the analysis five at a time. Each estimation process was iterated 10 times, using different random arrangements of the data and yielding an average result. The initial distribution was one with wide tails and, consequently, had little information content. Due to the Bayesian character of the technique used, and since the variances of the distributions of the parameters were also estimated, each estimate had an associated confidence interval calculated according to Raiffa & Schlaifer (1961). Once the analysis was completed, the probabilities of membership of each datum (specimen) to each component (species) were calculated by dividing the component density function weighted by its proportion in the mixture by the mixture density function.

As far as the interpretation of the results of the statistical analysis, the presence of two components in the mixtures was taken as evidence in support of a specific discrimination. Alternative interpretations based on other phenomena that yield mixed distributions in populations can be rejected as highly unlikely. For example, the species are hermaphroditic (Bacci 1947, Fretter & Graham 1976) and, therefore, sexual dimorphism is not a likely explanation for the presence of two components in the mixture. Mendelian segregation in the shell dimensions of these two species has never been reported, and it is likely that, as is the case with other organisms, traits related to body size are under additive polygenic control resulting in a normal distribution of shell height (Falconer 1989, Hartl & Clark 1989). Also, since the samples were collected in a uniform environment, a possible effect of disruptive selection and/or differential reaction can be safely discarded.

## RESULTS

Figure 1 shows a scattergram of the two variables measured on all the useful shells in the total sample. Visual inspection does not permit discrimination of two components in the cloud. However, the results of the mixture analysis leave no doubt as to the existence of two mixed distributions in most growth stages. A selection of these results is shown in Table 1 and plotted in Figure 2. The presence of two components in the sample can be inferred from: 1) the absence of empty components in the mixtures; 2) the absence of results suggesting a contribution from components with a marginal representation in the mixtures, as could arise from spurious frequency peaks in the tails of the distributions, and 3) a lack of overlap in the confidence limits around the shell height means for most growth stages. On the other hand, the estimated values of parameters confirm a substantial overlap in the distributions of shell heights for the two species.



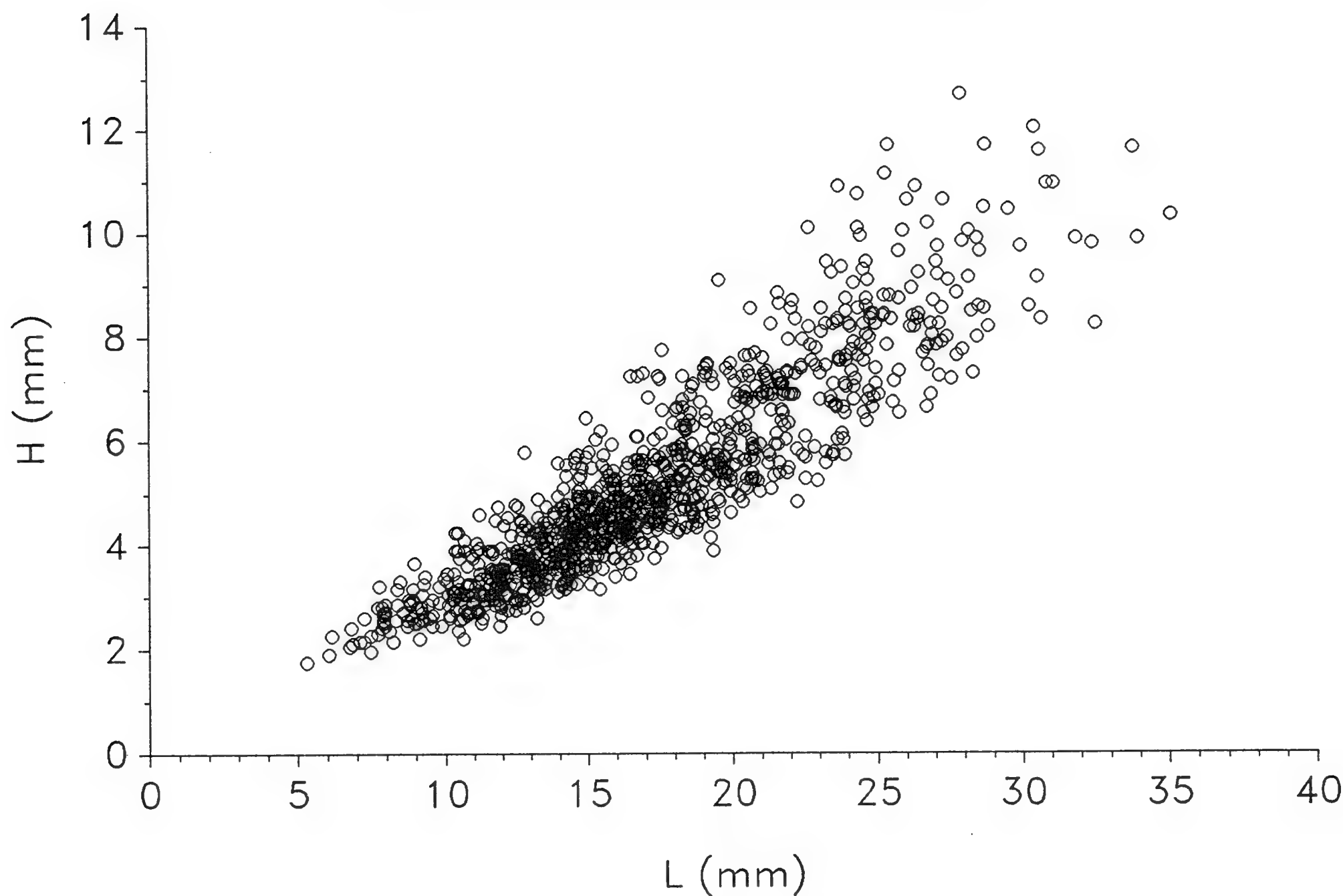


Fig. 1. Scattergram for the entire sample. L: shell length. H: shell height.

TABLE 1

Results of the mixture analysis. LI: shell-length interval (growth stage); N: subsample size; P1: proportion of the first component in the mixture; M1, M2: means; S1, S2: standard deviations.

LI (mm)	N	P1	M1 (mm)	M2 (mm)	S1 (mm)	S2 (mm)
7-8	18	0.72	2.58	2.41	0.34	0.35
8-9	17	0.64	2.93	2.65	0.37	0.35
9-10	19	0.71	2.85	2.66	0.35	0.35
10-11	46	0.50	3.45	2.90	0.43	0.33
11-12	59	0.44	3.62	3.06	0.45	0.33
12-13	63	0.26	4.30	3.45	0.47	0.39
13-14	64	0.57	4.17	3.54	0.46	0.37
14-15	103	0.39	4.87	3.92	0.52	0.41
15-16	88	0.50	4.96	4.09	0.50	0.40
16-17	80	0.20	5.74	4.50	0.59	0.42
17-18	68	0.17	6.54	4.88	0.52	0.42
18-19	66	0.39	6.30	4.99	0.46	0.42
19-20	57	0.24	7.39	5.43	0.51	0.53
20-21	48	0.45	7.07	5.55	0.49	0.40
21-22	44	0.59	7.21	5.91	0.52	0.45
22-23	23	0.62	7.95	5.69	0.65	0.42
23-24	39	0.28	8.95	6.79	0.59	0.67
24-25	37	0.30	9.22	7.53	0.59	0.58
25-26	15	0.24	9.85	7.58	0.48	0.55

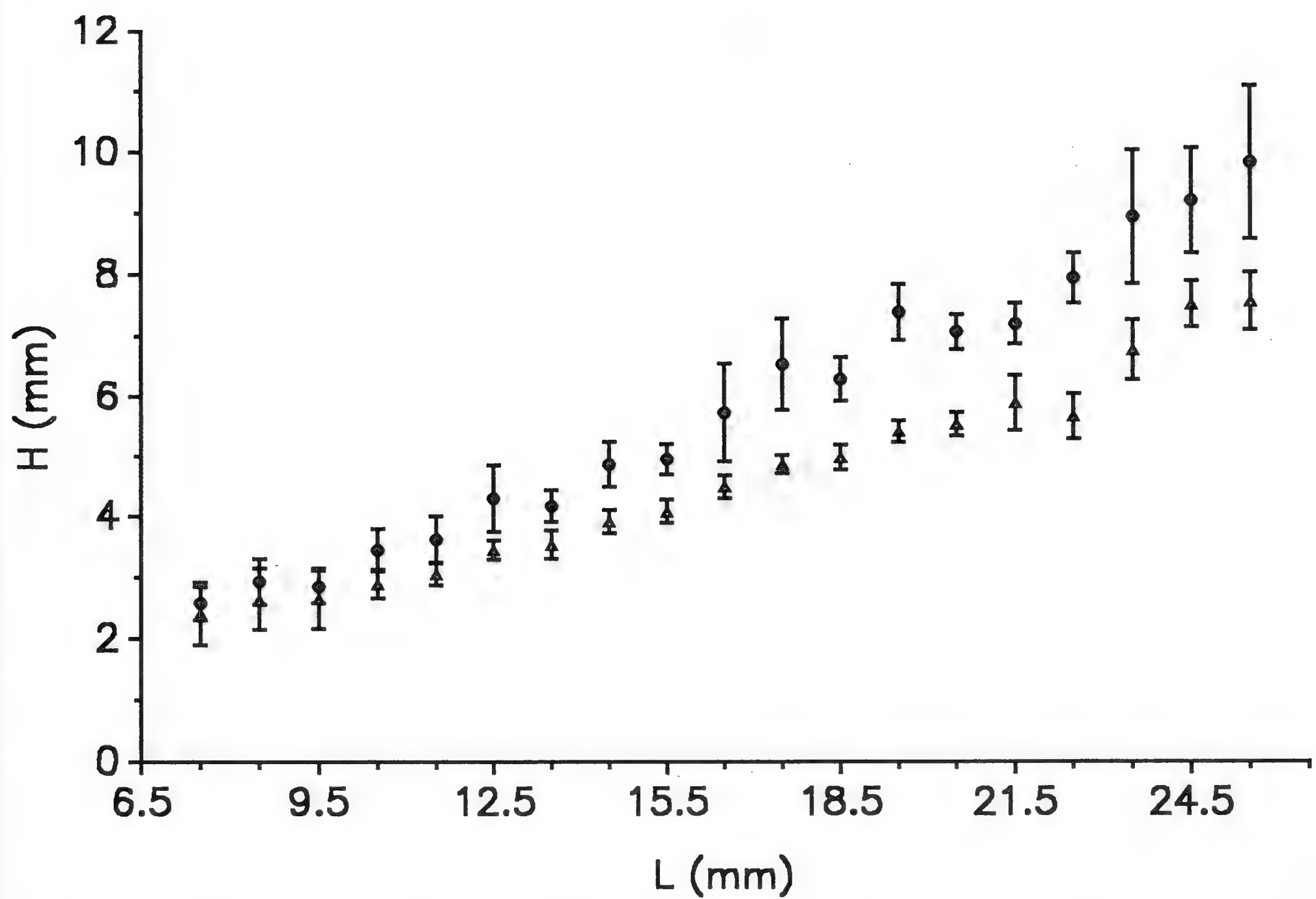


Fig. 2. Estimated means and 95% confidence intervals resulting from the mixture analysis. Abbreviations as in Figure 1.

The taxonomic interpretation of the results of the mixture analysis is straightforward if one considers simultaneously the probability that each specimen belongs to any one component in the mixture (Table 2) and the results of their specific diagnosis based on non-conchological traits (see Materials and Methods). When stringent probability levels are applied (e.g. 0.99) the classification derived from the mixture analysis is congruent with that based on non-conchological traits. With few exceptions, the component with the highest mean for each growth stage corresponds to *Patella aspera* shells, whereas the converse is true for the shells of *P. caerulea*. The number of incorrect adscriptions increases at lower probability levels (e.g. 0.75), but is always within the expected values. Therefore, it seems safe to conclude that the two components detected through the use of mixture analysis correspond to *P. aspera* and *P. caerulea*.

TABLE 2

A comparison of the classifications arising from mixture analysis and from specific diagnosis based on non-conchological traits. PM: probability of membership in a component; A: number of specimens adscribed to either component; IA: number of incorrect adscriptions; OIA: observed percentage of incorrect adscriptions; EIA: expected percentage of incorrect adscriptions.

PM	A	IA	OIA (%)	EIA (%)
0.99	207	10	4.83	1.00
0.90	514	49	9.53	10.00
0.75	750	166	22.13	25.00

## DISCUSSION

Shell height appears in almost every description of *Patella aspera* and *P. caerulea*. Often, the information provided in the literature includes only a qualitative estimate and/or values of height, width, and length considered as typical measurements (Bucquoy, Dautzenberg & Dollfus 1886, Powell 1973). Occasionally, more detailed data are provided, for example concerning variation in the height/length ratio (Ghisotti & Melone 1970, Sella & Bacci 1971, Christiaens 1973, Fretter & Graham 1976), but, in general shell height has received little attention as a diagnostic character for the discrimination of these two species.

However, the statistical analysis presented here reveals differences between the taxa in relation to this trait. Such differences, although not detectable from inspection of conventional scatterplots, are well within the limits of resolution of the method used. In light of these results, we conclude that shell height provides a reliable criterion for discrimination of these two species.

Our understanding of shell variation in *Patella aspera* and *P. caerulea* may benefit from the application of mixture analysis to other conchological traits besides shell height. A study of the distribution of shell width in shell-length class intervals, for instance, might contribute to an evaluation of the variation of the shape of the aperture. This trait, in contrast to the one used here, is frequently reported in the literature. Other characters such as shell colour and ornamentation, although requiring more elaborate measurements, may also be amenable to this type of analysis. Mixture analysis methods can be used as an effective tool for the extension of this work to other taxonomic characters and other taxa. Finally, multivariate mixture analysis could presumably be applied to simultaneously deal with all the available morphometric data.

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# TAXONOMY OF FIVE SPECIES OF *HELICOPSIS* (*HELICOPSIS*) FROM MOROCCO (GASTROPODA: HELICOIDEA)<sup>1</sup>

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**Abstract:** Five more species from the genus *Helicopsis* (*Helicopsis*) have now been confirmed from Morocco, greatly extending the range of the genus which is shown to be disjunct with species in central – eastern Europe and North-west Africa. These species are re-described using both shell and anatomical characters. The cause of this apparently disjunct distribution pattern is discussed with relation to the areas of taxonomic insufficiency and the impact of Pleistocene climatic change.

**Key words:** Lectotypes, shell descriptions, anatomy, penial papilla, disjunct ranges.

## INTRODUCTION

The genus *Helicopsis* (*Helicopsis*) currently contains thirteen species, which have been placed in this genus on the basis of genital anatomy (Hesse 1934, Ktari & Rezig 1976, Schileyko 1978, Giusti & Manganelli 1989, Hausdorf 1990, Gittenberger 1991, Giusti *et al.* 1992). The most widespread species *Helicopsis striata* (Müller) has a known range from central and eastern Europe westwards to easternmost France and Oland (Sweden), and eastwards into the Caucasus (Likharev & Rammelmeier 1962, Schileyko 1978, Kerney & Cameron 1979, Hausdorf 1990). This species had a more extensive range in the past as Sparks (1953) gives Late Pleistocene records from England. The other species apparently have more local distributions; seven species are restricted to southern European Russia (Hesse 1934, Schileyko 1978), two to Cyprus (Gittenberger 1991) and two species to Greece and Turkey (Hausdorf 1990).

The records of *Helicopsis* in NW. Africa given by Richardson (1980), including species described by Pallary, require investigation as they are based on conchological characters. The presence of one species from the genus *Helicopsis* (*Helicopsis*) in Tunisia was confirmed using anatomical characters by Ktari & Rezig (1976). Recently Giusti *et al.* (1992) also found a species of *Helicopsis* from Morocco, but they did not establish the identity of the species from the many species names available, suggesting that it may be conspecific with the Tunisian species, *Helicopsis bardoensis* (Bgt). In addition, a species of *Helicopsis* was described from Prov. Huelva in southern Spain (Gasull 1972), but Gittenberger (*pers. comm.* July, 1993) suggests that *Helicopsis gibilmanica* [= *H. altenai* (cf. Gasull, 1985)] “is similar in many respects to what is called *Xerotrichia apicina*”. Brandt (1959) studied many helicellinae from Cyrenaica, describing one species of *Helicopsis* (*Xeropicta*) [now regarded as a separate genus *Xeropicta*] but according to his anatomical results there are no species from the subgenus *Helicopsis* in NE. Africa. Although the knowledge of NW. African Helicidae is still

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rather scant, recent anatomical studies of *Xeroleuca* showed that this taxon should be regarded as a subgenus of *Helicopsis* (Aparicio, Seddon & Holyoak 1992).

This paper details the findings of some preliminary studies of the North African Helicidae. A diagnosis is given for each species incorporating shell and genital characters. Some comments are made on historical material from Museum collections, habitats and inferred distributions. It is not intended that the details of the latter three should be comprehensive as more material needs to be studied. However, we feel it appropriate to publish an interim report to reduce the likelihood of duplication of effort and to allow comparisons of the Maghreb faunas with other parts of the Mediterranean.

All of the material studied is kept in the Holyoak-Seddon Collections and the Melvill-Tomlin collections at the National Museum of Wales (NMW.Z). Type material from the Natural History Museum, London (BMNH) and the Muséum d'Histoire Naturelle, Paris (MNHN) was also examined.

***Helicopsis larbiana* (Pallary, 1927)**

(Fig. 1 ABC, Fig. 4 ABC)

*Xerophila larbiana* Pallary, 1927 *J. Conchyl., Paris*, **71**: 220–221. Pl. 1, Figs. 22, 23.

*Helicopsis larbiana* (Pallary, 1927): Richardson (1980) *Tryonia*: **3**: 178.

*Material examined*: Holyoak-Seddon Collection.: 0.5 km SE. of road at 12 km NNE. along road from Tounfite, E. Haut Atlas, Morocco (32°32'N, 5°11'W) (NMW.Z. 1993.051.16). 2 shells, 1 specimen in spirit, dissected.

*Comparative material*: Melvill-Tomlin Collection: *Xerophila saadensis* (Pallary, 1927) Bou Saada, Algeria [Coll. Pallary] NMW.1955.158.1589; *Xerophila gueltiana* (Pallary, 1913) Guelt-es-Stel, Algeria [Coll. Pallary] NMW.1955.158.1590; *Xerophila biaranaya* (Ancey), Algiers, Algeria [Coll. Ponsonby] NMW.1955.158.1591.

*Shell* (Fig. 1 ABC): The shell has 5–5.5 whorls. The shape is depressed, globular with a blunt keel. Below the keel the body-whorl is slightly convex; above the keel there is a slight concavity which gives the keel more prominence. The suture is moderately impressed. The umbilicus is moderately wide and deep. The upper part of the shell is light brown with some white thin bands on the radial ribs; on the underside there are three to five interrupted brown bands on a white background. The keel is accentuated by a prominent white band. The protoconch and first half whorls are more translucent and light brown in colour. The sculpture on the shell is of fine, regular, radial ribs but the first whorl and a half has no sculpture. On the last whorl the mouth starts to descend gradually giving an elliptical shape. The peristome is not continuous.

Shell measurements (Specimen figured); diameter 7.6 mm, height 4.3 mm.

*Genital anatomy* (Fig. 4 ABC):

The male portion has a small penis (2 mm) with a very short and thin retractor muscle. The epiphallus (4mm) is proportionately long (double the length of the penis). The flagellum (1.7 mm) is small and slender. The distal part of the penial papilla is enlarged and has a external sheath which basally expands to reach and fuse with the penial walls (Fig. 4C).

Female organs: there are four clearly distinguishable, medium-sized dart-sacs (1.2 mm). The vaginal digitiform glands have seven long terminal tubes and are situated above the dart sacs inserting just below the spermathecal duct. These glands have an unusual shape with the central portion enlarged (Fig. 4B). The Spermathecal duct is very short (1.5 mm). The Spermatheca has an elongate, bean-like shape (3 mm).



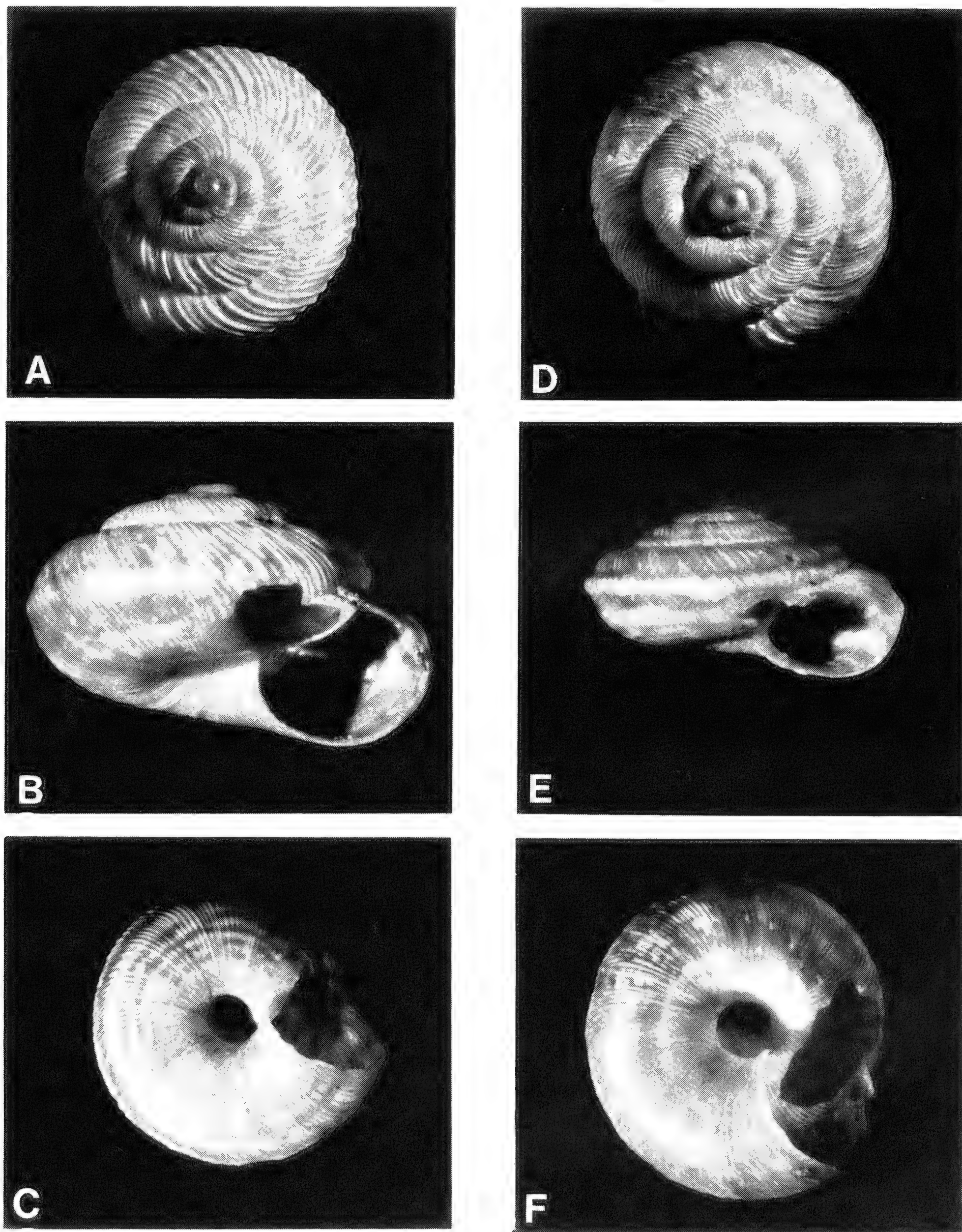


Fig. 1 A B C *Helicopsis larbiana* (Pallary, 1927). Holyoak-Seddon Collection.: 0.5 km SE. of road at 12 km NNE. along road from Tounfite, E. Haut Atlas, Morocco (32°32'N, 5°11'W) (NMW.Z. 1993.051.16). Overall dimensions of specimen: 7.6 mm, 4.5 mm.

D E F *Helicopsis carrossei* (Pallary, 1936). Holyoak-Seddon Collection.: Ait-Saoun (SE. of Ouazzazate) Vallee du Draa, Morocco (Lat. 30° 43'N, Long. 6°36'N) (NMW.Z. 1993.051.17). Overall dimensions of specimen: 7.6 mm, 4.7 mm.

*Locality:* Material dissected was from near Tounfite, E. Haut Atlas, Morocco (32°32'N, 5°11'W), close to the Upper Mouloya valley which separates the Haut Atlas from the Moyen Atlas.

*Ecology:* The substrate was calcareous sandstone and limestone. The specimens were found on open, unshaded rocky slopes under boulders of limestone. The local vegetation was sparse grasses and herbs with occasional bushes (junipers). The elevation was approximately 2100 m ASL.

*Taxonomic notes:* There are many shells described from N. Africa and S. Europe which have a similar appearance to our shell. Comparisons were made with shells described from Morocco, W. Algeria and Spain.

Pallary (1927) described *X. larbiana* from Arbalou-Larbi between Timhadit and Midelt (S. Moyen Atlas). Given that the type locality is reasonably close to our site and the species descriptions and illustrations are the best match for our material, we have used this name. However, we have been unable to locate type material bearing this name.

Other species from adjacent regions (Atlas Saharien in Algeria) also had similar shell characters. Examination of Pallary syntypes of *X. saadensis* (Pallary, 1927), and *X. gueltiana* (Pallary, 1913) showed that our material from Tounfite was similar, but not identical, in size, shape, keel, with finely to medium costulate ribbing. The shell colouration had been removed but the material examined appeared subfossil. Furthermore in the modern collections made though the Atlas Saharien there is similar conchological material which occurs in intervening localities and extending westwards towards Figuig. This suggests that the range of these species could be expanded, although examination of the genital anatomy of these species is needed to confirm this. If these species are conspecific, then the oldest name would have priority.

Pallary (1927) compared *X. larbiana* with *X. biaranaya* (Ancey) from W. Algeria. Examination of shell material shows that this species has a similar sized shell, but is more keeled, with stronger ribbing, a more rapidly expanding last whorl and the shell colour is whitish with brown flecks (not brown).

According to Fig. 4C the structure of the penial papilla of this species is similar to that of *Helicopsis striata* (Schileyko 1978, Giusti *et al.* 1992).

### ***Helicopsis carrossei* (Pallary, 1936)**

(Fig. 1 D E F, Fig. 4 D E F)

*Xerophila* (*Xerotrichia*) *carrossei* Pallary, 1936 *J. Conchyl.*, Paris, **80**: 11–12, Fig. 2.

*Helicella* (*Xerotrichia*) *carrossei* (Pallary, 1936): Richardson (1980) *Tryonia*: **3**: 171.

*Material examined:* Holyoak-Seddon Collection.: Aït-Saoun (SE. of Ouazazate) Vallee du Draa, Morocco (Lat. 30°43'N, Long. 6°36'E) (NMW.Z. 1993.051.17; 7 shells, 1 specimen dissected).

*Material of allied species from Melvill-Tomlin Collection:*

*Polytrichia polytrichia* (Ancey) Oran, Algeria. NMW.1955.158.1592.

*Polytrichia medacula* var. *takandoutiana* (Pallary, 1913) Syntype, Dar M'tougui [Coll. Pallary]. NMW.1955.158.1593.

*Polytrichia thomsoni* (Pallary, 1922) Syntype, El Hajeb, Morocco [Coll. Pallary] NMW.1955.158.1594 (Fig. 5 A).



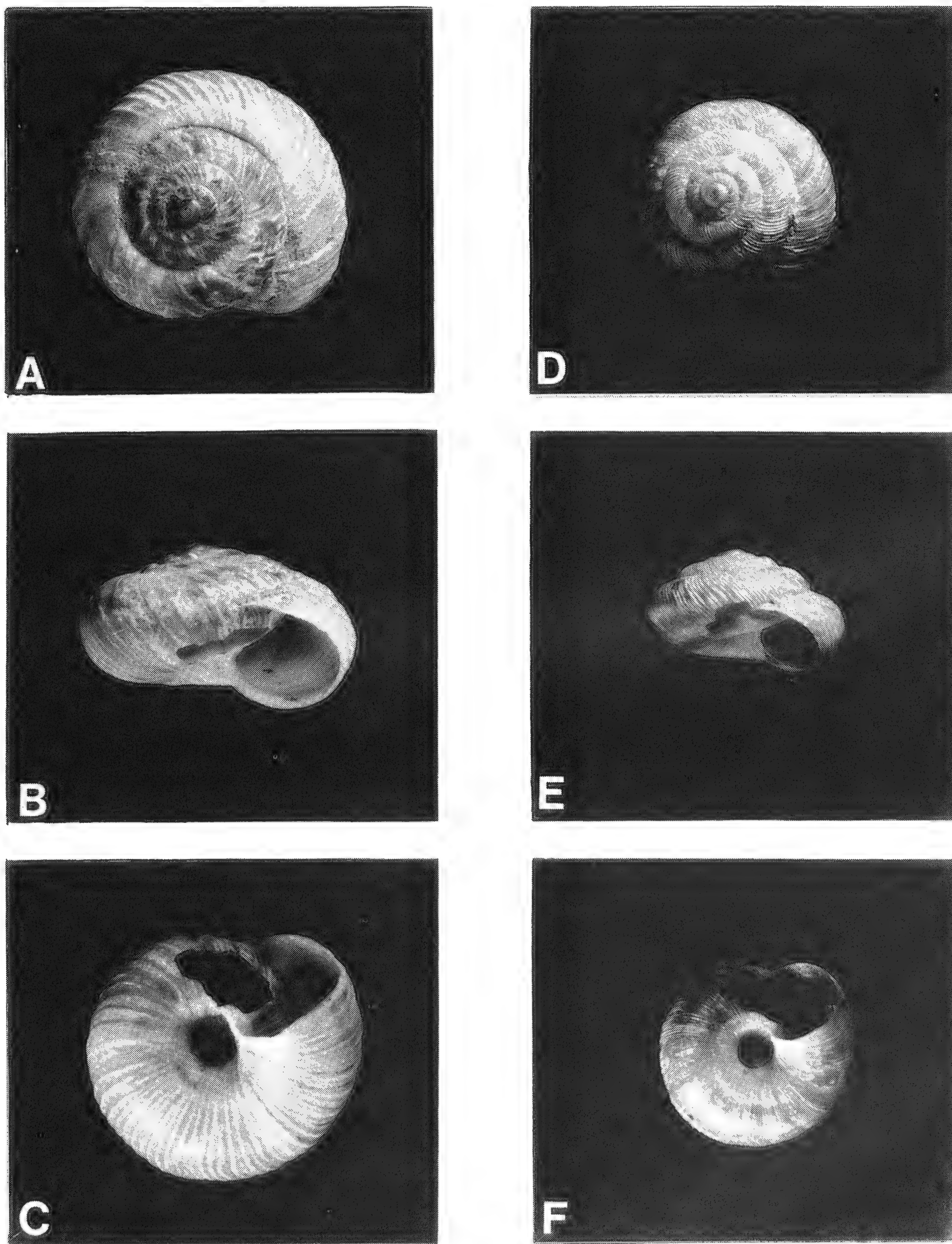


Fig. 2 A B C *Helicopsis teboudensis* (Pallary, 1927). Holyoak-Seddon Collection.: by S 330 24 km W. along road from Ain Beni-Mathar [= Berguent], NE. Morocco (34°01'N, 2° 15'W) NMW.Z 1993.051.18 (shells and spirit material). Overall dimensions of specimen: 9.8 mm, 7.1 mm.

D E F *Helicopsis anflousiana* (Pallary, 1913). Holyoak-Seddon Collection.: by P 31 2.5 km SSW. along the road from Tizi-n-Tichka (31°17'N, 7°22'W) NMW.Z 1993.051.22. Overall dimensions of specimen: 5.5 mm, 4.9 mm.

*Xerophila ourebasiana* (Pallary, 1933) Syntype, Marrakech, Morocco [Coll. Pallary]. NMW.1955.158.1595 (Fig. 5 B).

*Helicopsis abarriana* (Pallary, 1923) Syntype, Marrakech, Morocco [Coll. Pallary] NMW.1955.158.1596.

*Shell* (Fig. 1 D E F): The shell has 5.5 whorls. The shape is conical to globular with a blunt keel. The suture is moderately impressed. The umbilicus is relatively wide and deep. The main part of the shell is dark brown with some white thin bands on the radial ribs; on the underside the shell is creamy white with sporadic cover of light brown flecks. The protoconch and first half whorls are more translucent. The sculpture on the shell is of fine, regular, radial ribs. The protoconch and first half whorls have no sculpture. On the last eighth of a whorl the mouth starts to descend gently to give an elliptical shape to the mouth. The peristome is not continuous.

Shell measurements (specimen figured); overall diameter 7.6 mm, height 4.7 mm.

*Genital anatomy*: (Fig. 4 D E F): The male portion has a small penis (length 1.5 mm) with the central part enlarged containing the broad penial papilla (Fig. 4 F). The internal wall of the penis around the proximal part of the penial papilla has pronounced folds (Fig. 4 F). The retractor muscle of the penis is short and wide. The epiphallus (3 mm) is double the length of the penis and relatively thick. The flagellum (0.7 mm) is comparatively short, becoming more slender towards the end.

The female portion has four, clearly distinguishable, medium-sized, dart-sacs (1 mm) (Fig. 4 D E). The vaginal digitiform glands are situated behind and below the dart-sac complex inserting below the junction with the spermathecal duct; there are seven to eight terminal tubes. These glands have an unusual shape with the central portion enlarged (Fig. 4 E). The duct of the Spermatheca is relatively long (2.5 mm). The Spermatheca is bean-like in shape.

*Range*: The material dissected came from a locality by P31 5km SE. along road from Ait-Saoun (SE. of Ouazzazate; near the pass of Tizi-n-Tiniffit in the Jbel Anaour) near the Vallée du Draa, Morocco (Lat. 30°43'N, Long. 6°36'N). The type locality for *Xerophila carrossei* was given by Pallary (1936) as Zagora in the valley of the Draa.

*Ecology*: This species was found on rocky slopes with low crags of sandstone and conglomerate at the edge of the Anti Atlas at about 1615 m ASL. The sparse vegetation cover was provided by herbs and grasses.

*Taxonomic notes*: The specimens dissected came from a montane site at the edge of the Anti Atlas close to the Vallee du Draa. Comparison was made with species reported by Pallary from adjacent regions of the Anti Atlas, Valley du Draa and the Haut Atlas. Pallary (1936) described *Xerophila carrossei* from near Zagora in the Vallee du Draa; the species description and illustrations resemble our species. We have not located any type material in our searches in museum collections (BMNH, MNHN, NMW.Z).

The specimen from Ait Saoun is also similar to the shell of *Xerophila ourebasiana* (Pallary, 1933) but differs in being smaller (mean breadth 6.7; mean height 4.57 cf. 7.5 mm, 4.85 mm); mottled horn-brown and cream rather than the more uniform horn brown; the ribbing is slightly less prominent and more irregular: the suture not as impressed as with our specimens (Fig. 5B). The localities given by Pallary (1933) for this species are all on the north side of the Haut Atlas, near to Marrakech, hence rather distant from Ait Saoun (Fig. 6).



Other similar species known only from the shell descriptions differ in the following characters:

*Helicopsis abarriana* (Pallary, 1923) has a slightly higher shell (6.5 mm cf. 4.8 mm) with more strongly developed, widely spaced radial ribs. *Polytrichia polytrichia* (Ancey, 1882) has a flatter shell with hairs, is whitish with brown flecks (not uniform brown colouration). *Polytrichia medacula* var. *takandoutiana* (Pallary, 1927) from the Haut Atlas has a slightly smaller shell (6.5 mm cf. 7.5 mm) with hairs and is whitish with brown flecks and a narrower umbilicus. *Polytrichia thomsoni* (Pallary, 1927) from N. Moyen Atlas (near Fez) has a larger shell with hairs, which is whitish with brown flecks (Fig. 5A). The genital anatomy of *Polytrichia polytrichia* (the type species of the genus) is unknown, whereas the genital anatomy of this species is within the range of the genus *Helicopsis*, so we consider that this species belongs to the genus *Helicopsis*.

***Helicopsis teboudensis* (Pallary, 1927)**

(Fig. 2 A B C, Fig. 4 G H J K)

*Xerophila teboudensis* Pallary, 1927 *J. Conchyl., Paris* **71**: 208–209. Plate 4, Figs 8,9.

*Helicopsis teboudensis* (Pallary, 1927): Richardson (1980) *Tryonia* **3**: 182.

*Lectotype*: *Xerophila teboudensis* Pallary, 1927 Tebouda, NE. Morocco [Coll. Pallary], NMW 1955.158.1597.

*Paralectotypes*: *Xerophila teboudensis* Pallary, 1927 Tebouda, NE. Morocco [Coll. Pallary], NMW 1955.158.1598 Natural History Museum London: *Xerophila teboudensis* Pallary, 1927 Tebouda, NE. Morocco; [Coll. Pallary] BMNH 1937.12.30.11010-11013.

*Material examined*: Holyoak–Seddon Collection.: by S 330 24 km W. along road from Ain Beni-Mathar [= Berguent], NE. Morocco (34°01'N, 2°15'W) NMW.Z 1993.051.18 (shells & spirit material; 3 specimens dissected); by S 330 14 km NW. along road from Ain Beni-Mathar [= Berguent], NE. Morocco (34°02'N, 2°09'W) NMW.Z 1993.051.19, 6 shells; by P19 62 km S. along road from Ain Beni-Mathar [= Berguent], NE. Morocco (33°29'N, 1°56'W) NMW.Z 1993.051.20, 12 shells–subfossil; by P19 22.5 km N. along road from Tendrara, NE. Morocco (33°14'N, 1°59'W) NMW.Z 1993.051.21, 47 shells.

*Comparative type material*: Melvill-Tomlin Collection: *Xerophila verignoni* Pallary, Moulay Taiebi, NE. Morocco [Coll. Pallary], syntypes NMW.1955.158.1599 Natural History Museum London: *Xerophila guersiana* var. *outatiana* Pallary, 1927 Syntypes, Midelt, Morocco; [Coll. Pallary] BMNH 1937.12.30.10743.

*Shell* (Fig. 2 A B C): The depressed, globular shell has 4.5–5.5 whorls with a moderately impressed suture. The umbilicus is moderately wide and deep. The main part of the shell is opaque, horn brown with creamy flecks, most prominent on the radial ribs of the body whorl. The protoconch and first half whorls are more translucent and light brown in colour. The sculpture is prominent on the entire shell; it is composed of strong, regular, radial ribs with the interval between the ribs increasing from whorl to whorl. The protoconch has no sculpture. The aperture is nearly circular as the body-whorl does not descend towards the mouth. The peristome is not continuous and there is no internal rib behind the lip of the mouth.

Overall shell measurements of specimens dissected; diameter 9.8 mm, height 7.1 mm.



*Genital anatomy* (Fig. 4 G H I J K): Male organs; The penis (2.5-2.7 mm) is relatively long with a slightly enlarged central part (Fig. 4 H I J). The penial papilla has an almost circular cross-section, with a slightly wider central part and a more slender distal portion. Ejaculatory pore at end of penial papilla is slit like (Fig. 4 H). The proximal portion of the interior wall of the penis shows fine folds (Fig. 4 J). The retractor muscle is short and wide. The epiphallus (4mm) is longer than the penis. The slender flagellum (2.2-2.5 mm) is about the same length as the penis.

Female organs; there are four clearly distinguishable, medium-sized dart-sacs (1.5 mm). The external dart-sacs appears slightly larger than the inner sacs, and they contain a dart (0.8 mm) which fills the inner space within the dart-sacs (Fig. 4 G). The walls of the dart-sac are relatively thick. The vaginal digitiform glands are situated just above the dart-sacs below the intersection of the duct of the Spermatheca and the ovispermiduct and have six to eight terminal tubes. The duct of the Spermatheca (4 mm) is very long, more than twice the length of the Spermatheca. The Spermatheca is bean-like in shape.

*Range:* The specimens dissected came from a site west of Aïn Beni-Mathar [= Berguent], NE. Morocco which is about 12 km NW. of the type locality of *Xerophila teboudensis*. Shells were collected from sites from Tendrara in the south through to Aïn-Beni Mathar in the North. This region is western extension of the Haut Plateaux of Algeria (Fig. 6).

*Ecology:* The site where living material was obtained was on a extensive silty plain with scattered rocks on the surface at 1050 m elevation. The vegetation cover was sparse; mainly of low herbs. Shells of *Otala* sp. (and sub-fossil shells of *Melanopsis* sp.) were also found. Elsewhere shells were found on rocky slopes of calcareous sandstone with sparse grasses and herbs. The sites ranged in elevation from 980 to 1300 m. Other species found in association were *Rumina decollata*, *Sphincterochila* cf. *candidissima*, *Helicopsis* (*Xeroleuca*) *turcica* (1 site) and *Otala* sp. (1 site).

Sub-fossil shells were found on the open, sparsely vegetated plains south of Aïn Beni Mathar to Tendrara.

*Taxonomic notes:* Shells of *Helicopsis teboudensis* were recorded by Pallary (1927) from various localities in NE. Morocco, including Tebouda (c. 12 km NNE. of Ain Beni-Mathar) and Matarka (Fig. 6).

Comparison with Pallary syntypes showed that this species provides the closest match to our specimens. There are slight differences in shell characters namely smaller size, 9.8 mm cf. 13 mm (Pallary 1927), slightly rougher ribbing and slightly flatter spire. However, Pallary (1927) comments on variation in the shell form with different populations. The Pallary material in the NMW.Z collections were all sub-fossil shells. The living material studied in this paper is smaller but the sub-fossil material in Holyoak-Seddon Colln. is within the range reported by Pallary (1927). Following this revision in order to stabilise the nomenclature we designate one specimen from the type locality as a lectotype and the others as paralectotypes.

Pallary (1927), in his original description, compares this species with *Helix subcostulata* (Bgt., 1863) from South Oran (Djelfa); our specimens and Pallary specimens have been compared with specimens and descriptions of *H. subcostulata* which is much smaller (c. 6.5 mm breadth), with finer radial ribbing.

There are other species with similar shell characters described by Pallary from adjacent regions. *Xerophila verignoni* (Pallary, 1918) is known from Mouloya valley: the type locality is Moulay Taieb (28 km W. of El Aioun) on the left bank of Oued Ksob. This shell differs from our specimens in larger size and much stronger, more widely spaced radial ribs. *Xerophila edrissiana* (Pallary, 1918) (Fig. 5C) is also known from in the upper Mouloya valley extending

to the edge of the Haut Plateaux. Pallary (1927) reported that this species ranged in size with the breadth of typical shells from Taourirt, Mahirija and Guettera being 14 mm. Further south-west in the Mouloya valley around Missouri the shells are larger (Pallary 1927: var. *major*, 21mm breadth). Our shell differs from both in being smaller, less conical, without the blunt keel on the body whorl, and more strongly ribbed with a narrower umbilicus. Pallary (1927) illustrates a range of shells under the name *Xerophila guersiana* giving them varietal names: var *outatiana* (Pallary, 1927) from Midelt in the Upper Mouloya valley is most similar to our specimens. Examination of Pallary syntypes show that the shell differs in being a fairly smooth (not costulate), whitish calcareous shell (not brownish).

***Helicopsis anflousiana*** (Pallary, 1913)  
(Fig. 2 D E F, Fig. 4 L M N O)

*Xerophila anflousiana* Pallary, 1913. *Bull. Mus. Hist. nat., Paris* **6**: 361–362.

*Polytrichia anflousiana* (Pallary, 1913): Pallary (1920) *J. Conchyl., Paris* **65**: 12.

*Helicopsis anflousiana* (Pallary, 1913): Richardson (1980) *Tryonia* **3**: 17.

*Material examined:*

*Type material:* Lectotype designated *Xerophila anflousiana* (Pallary, 1913) syntype, Dar Anflouss, Morocco [Coll. Pallary], Muséum Nationale d'Histoire Naturelle, Paris.

*Paralectotypes:* NMW.Z, Cardiff, Melvill-Tomlin Collection: *Xerophila anflousiana* (Pallary 1913) Aguergour, Morocco [Coll. Pallary] NMW 1955.158.1600. BMNH, London: *Xerophila anflousiana* (Pallary, 1913) Aguergour, Morocco [coll. Pallary] BMNH 1937.12.30.10689-92. NMW.Z, Cardiff, Holyoak-Seddon Collection.: By P 31 2.5 km SSW. along the road from Tizi-n-Tichka (31°17'N, 7°22'W) NMW.Z 1993.051.22, 4 shells, 1 specimen dissected; by P 31 4 km NW along road from Agouim (31°11'N, 7°27'W), NMW.Z 1993.051.23, 8 shells, 1 specimen dissected.

*Shell* (Fig. 2 D E F): The shell has  $5\frac{1}{4}$  whorls, and is conical to globular in shape. The suture is moderately impressed. The umbilicus is relatively narrow and deep. The shell is horn brown with a few upstanding white ribs. Fresh shells are covered with small slightly curved hairs. When the shells are worn this results in small tubercles remaining where the hairs have been lost (as with specimen designated as lectotype). The first one and a half whorls have no hairs. The sculpture on the upperside is of fine, regular, radial ribs; the interval between the ribs increases from whorl to whorl. On the underside of the shell the sculpture is less developed except just behind the mouth. The radial ribs continue over the keel to the edge of the umbilicus. The protoconch has no sculpture. On the last third of a whorl the mouth starts to descend gently. The mouth is round and the peristome is not continuous.

*Shell measurements*; diameter 5.5 mm, height 4.9 mm.

*Genital anatomy* (Fig. 4 L M N O): Male organs: the penis (1.5–2 mm) has a slightly enlarged anterior portion (Fig. 4 LM). The penial papilla has an irregular shape with slight folds on the central part and a rather irregular surface (Fig. 4 N O). The penis wall is very thin. The retractor muscle of the penis is proportionately long and wide. The epiphallus (2–2.5 mm) is slightly longer than the penis. The flagellum (3 mm) is very long, more than twice the length of the penis.

Female organs; there are four clearly distinguishable, medium-sized, dart-sacs (0.8–1.0 mm). The vaginal digitiform glands are situated beneath and behind the dart-sac complex.

There are eight to ten terminal tubes. The duct of the Spermatheca is quite long (3.0 -3.5 mm). The Spermatheca is bean-like in shape.

*Range:* The material dissected came from two localities SE. of Marrakech in the central part of the Haut Atlas of Morocco; Tizi-n-Tichka (31°17'N, 7°22'W) and Agouim (31°11'N, 7°27'W).

*Ecology:* At Tizi-n-Tichka specimens were collected from a flushed area on a rocky sandstone hillside. The vegetation cover was reeds (*Juncus*), herbs and grasses. The species was living with *Lymnaea truncatula* (Müller). The elevation of the site was estimated as 2200 m ASL. At Agouim further south-east (and lower, 1760 m, in the same valley) the specimens were found on sparsely vegetated, rocky slopes of calcareous sandstone. At this site the only other species recorded was *Rumina decollata* (L.).

*Taxonomic and nomenclatural notes:* The original description gives the type locality as 'the foot of the cliffs at Dar Anflouss' (Pallary 1913). Thus we designate the Paris specimen as a Lectotype of *Xerophila anflousiana* (Pallary, 1913) on the grounds that this specimen was part of the syntypic series from Dar Anflous. Pallary material available in Cardiff and London came from Aguergour and hence although identified by Pallary it is not part of the original type series. However, these shells are designated as Paralectotypes in that they were cited material in Pallary's subsequent papers, and these shells are not as worn and therefore are more typical than the lectotype. Pallary (1921) comments that at Aguergour the shell shape is very variable and some specimens were larger (var. *major* 7.5 mm cf. 4.75 mm). However, some of the shells from Aguergour in museum collections were smaller than var. *major* and within the size range given in the first description of the species, whereas in Paris collection other shells appeared to be a different larger species, and this may well be the larger material referred to in Pallary's paper (possibly *Polytrichia thomsoni* var. *minor*, see note below). Our shells were extremely similar to Pallary shells from Aguergour. The localities given by Pallary (1921) for this species suggest a distribution range in the Haut Atlas south of Marrakech (Ahmed Saih, Dar Anflous, Amizmiz, Aguergour) and our material was collected from the same region (Fig. 6). Thus the name *anflousiana* has been given, as the anatomy described above, relates to animals from shells which are similar to Pallary material of *Xerophila anflousiana* in the collections at Paris, Cardiff and London, and to his descriptions (Pallary 1913, 1920, 1921).

Pallary (1920) also gave one locality in the Moyen Atlas (Tazouta) but in error as the description and illustration of *Xerophila anflousiana* in this paper were realised to be *Polytrichia thomsoni* var. *minor* (Pallary, 1921).

Pallary (1921) compares this species with *X. psara* Bgt. from Algeria [= *Xerotrichia conspurcata* (Draparnaud)] and *X. belloquadrica* Mabilie of SE. France [= *Candidula unifasciata* Poiret] and *X. penchinati* Bgt. [= *Trochoidea (Xerocrassa) penchinati*]. The most similar species is *Xerotrichia conspurcata* (Draparnaud). This species differs from *H. anflousiana* in having a more flattened (less globular) shell with sparse, irregularly spaced, long hairs. *H. anflousiana* also differs in genital characters: species in the genus *Xerotrichia* are defined on the basis of two dart-sacs with two accessory sacs that can hardly be seen (Hausdorf 1988, Gittenberger 1991, Giusti *et al.* 1992).

Another species which has similar shell characters is *Microxeromagna armillata* (Lowe), formerly known as *Microxeromagna vestita* (Rambur), a species that is widespread through the Mediterranean from Madeira to the Lebanon (Gittenberger 1991). Although the hairs of *H. anflousiana* have equivalent length and density to *Microxeromagna armillata*, the shell differs in having a wider umbilicus, smaller protoconch, more rapidly expanding whorls and the ribbing is more finely spaced.



***Helicopsis cf. welschi*** (Pallary, 1898)  
(Fig. 3 A–E, Fig. 4 P–U)

*Helix (Xerophila) welschi* Pallary, 1898. *J. Conchyl., Paris* **46**: 91, pl. 5, fig. 14.

*Xerophila welschi* (Pallary, 1898): Pallary (1921) *J. Conchyl., Paris* **66**: 132.

*Cernuella welschi* (Pallary, 1898): Richardson (1980) *Tryonia* **3**: 13.

*Lectotype*: Natural History Museum, London: *Xerophila welschi* Pallary, 1898 [Coll. Ponsonby] BMNH 1913.3.14.14. Fig. 3 D E F.

*Type locality*: Marrakech, Morocco.

*Material examined*: Holyoak-Seddon Collection. By P32 c. 7 km SE. of Taliouine, Morocco (30°30'N, 7°52'W) NMW.Z 1993.051.24, 3 specimens dissected; by track 1 km SE. of Ammain, Morocco, (30°28'N, 8°00'W) NMW.Z 1993.051.25; by road 7074 4 km SE. of Assaka, Morocco, (29°11'N, 9°30'W) NMW.Z 1993.051.26; coast by road 7064 2 km NE. of Mirleft, Morocco, (29°36'N, 10°02'W) NMW.Z 1993.051.27; by S501 c. 4 Km NW. of Tafingoult, W. Haut Atlas, Morocco, (30°48'N, 8°24'W) NMW.Z 1993.051.28; by S511 c. 11Km NW. of Imi-n-Tanout, W. Haut Atlas, Morocco, (31°07'N, 8°54'W) NMW.Z 1993.051.29.

*Shell* (Fig. 3 A B C): The globular shell has 5–5.5 whorls; the body whorl expanding rapidly. The suture is only slightly impressed, giving a smooth convex profile to the upper portion of the shell. The umbilicus is relatively narrow but deep. The upper part of the shell is mottled in colour; creamy white combined with light brown; just above the suture there is an interrupted dark brown band. On the underside the shell is mainly creamy white with two broad, diffuse (often faint), brown spiral bands. The protoconch and first half whorls are more translucent and light brown in colour. The sculpture on the upperside is of fine, regular, radial ribs; the interval between the ribs increases from whorl to whorl. The first whorl has little sculpture. On the underside of the shell the sculpture is less prominent. The radial ribs continue over the keel to the edge of the umbilicus. On the last tenth of a whorl the mouth starts to descend gently. The mouth is elliptical. The peristome is not continuous. The lip of the columellar axis of the mouth is slightly reflected, beginning to cover the umbilicus. Inside the mouth running parallel to the lip there is a white rib.

*Shell measurements*: (Shell figured) diameter 11.8 mm, height 7.7 mm.

*Genital anatomy* (Fig. 4 P–U): Male organs; The penis (length 2.5–3 mm) is quite long, with the central part slightly enlarged. Within this central portion is the penial papilla which is attached to the wall by a pilaster. In two specimens the pilaster was attached from about midway from the distal end of the papilla to the penis wall near the proximal end of the papilla (Fig. 4 S T). In one specimen the pilaster was attached from the proximal end of the penial papilla to the wall at the distal end of papilla (Fig. 4 U). The retractor muscle of the penis is short. The epiphallus (4–4.5 mm) is long and slender. The flagellum (6–7 mm) is very long, more than twice the length of the penis.

Female organs; there are four clearly distinguishable, medium-sized dart-sacs (1.2–2 mm). The external dart-sacs are slightly larger and contain a dart of simple structure. The inner dart-sacs did not contain a dart although these opened into the vagina. The vagina is wider between the paired dart-sacs than the other species described in this paper and the interior wall shows regular folds (Fig. 4 R). The vaginal digitiform glands have six, seven or eight terminal tubes that originated from four points around the vagina (some tubes bifurcate close to the vagina). These are situated above the dart-sacs just below the point where the

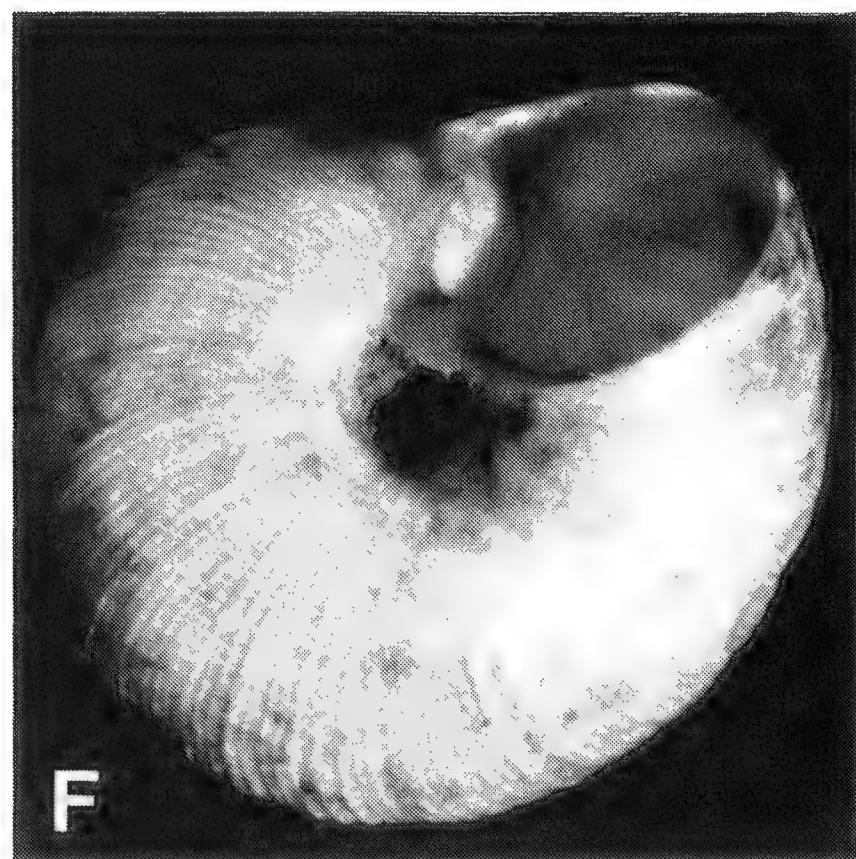
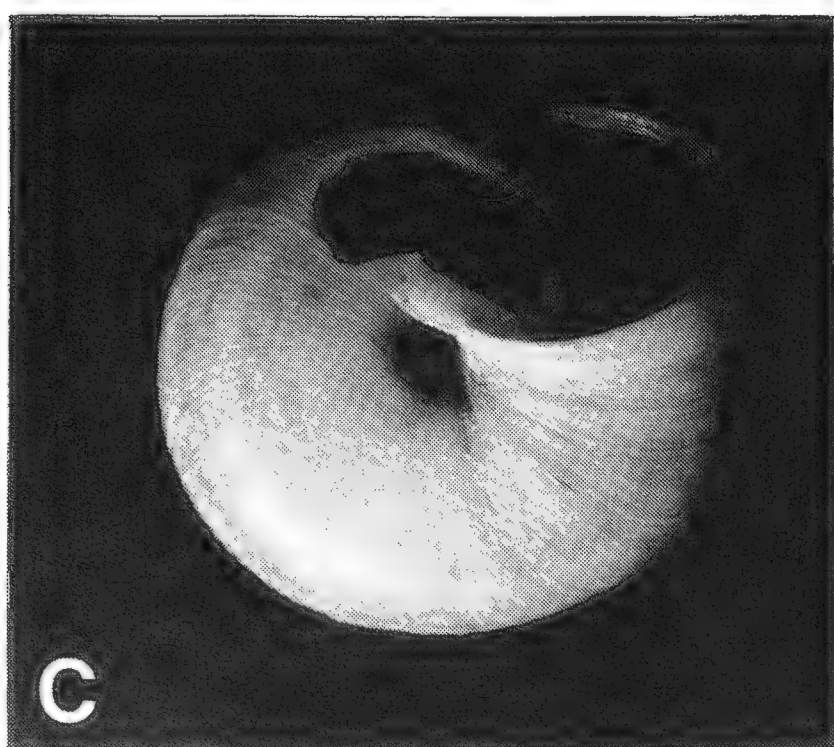
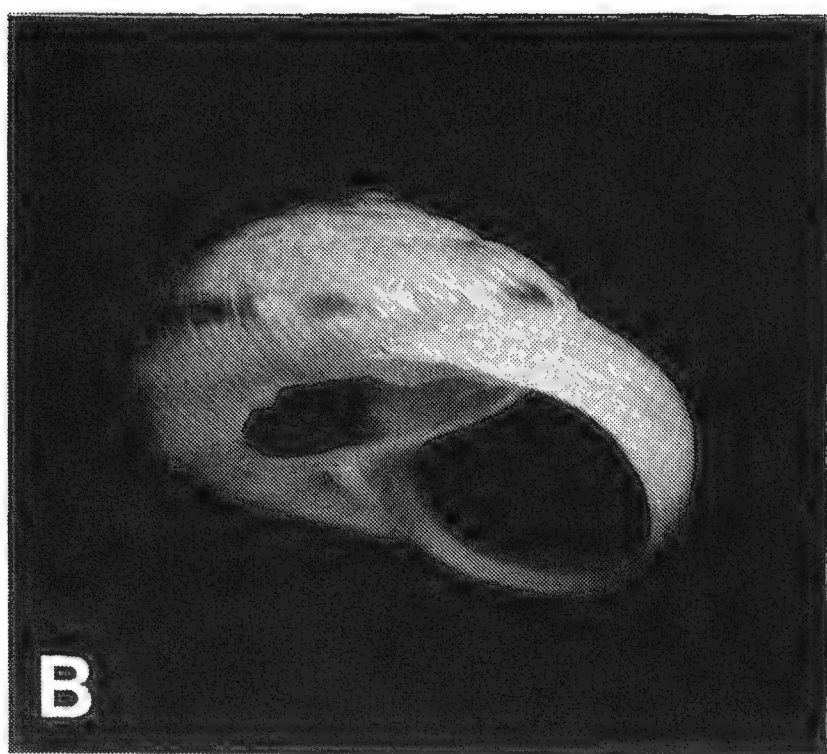
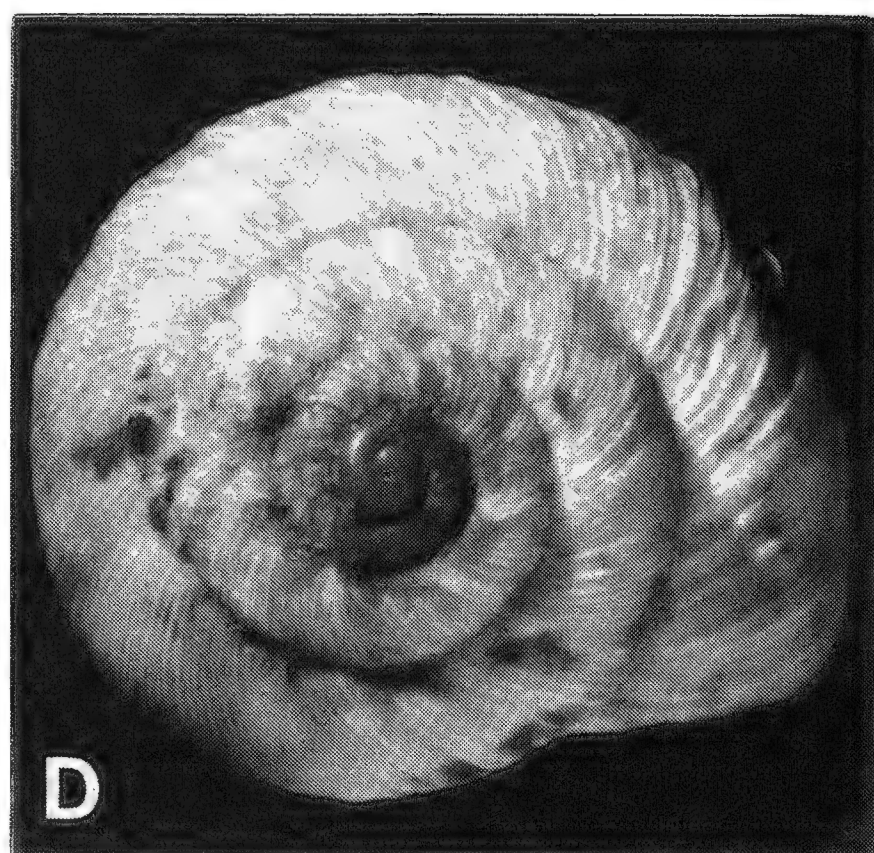


Fig. 3 A B C *Helicopsis* cf. *welschi* (Pallary, 1898). Holyoak-Seddon Colln.: by P32 c. 7 km SE. of Taliouine, Morocco (30°30'N, 7°52'W) NMW.Z 1993.051.24. Overall dimensions of specimen: 11.9 mm, 7.2 mm.  
D E F *Helicopsis welschi* (Pallary, 1898) Lectotype, Natural History Museum (BMNH. 1913.3.14.13). Overall dimensions of specimen: 11.9 mm, 7.2 mm.



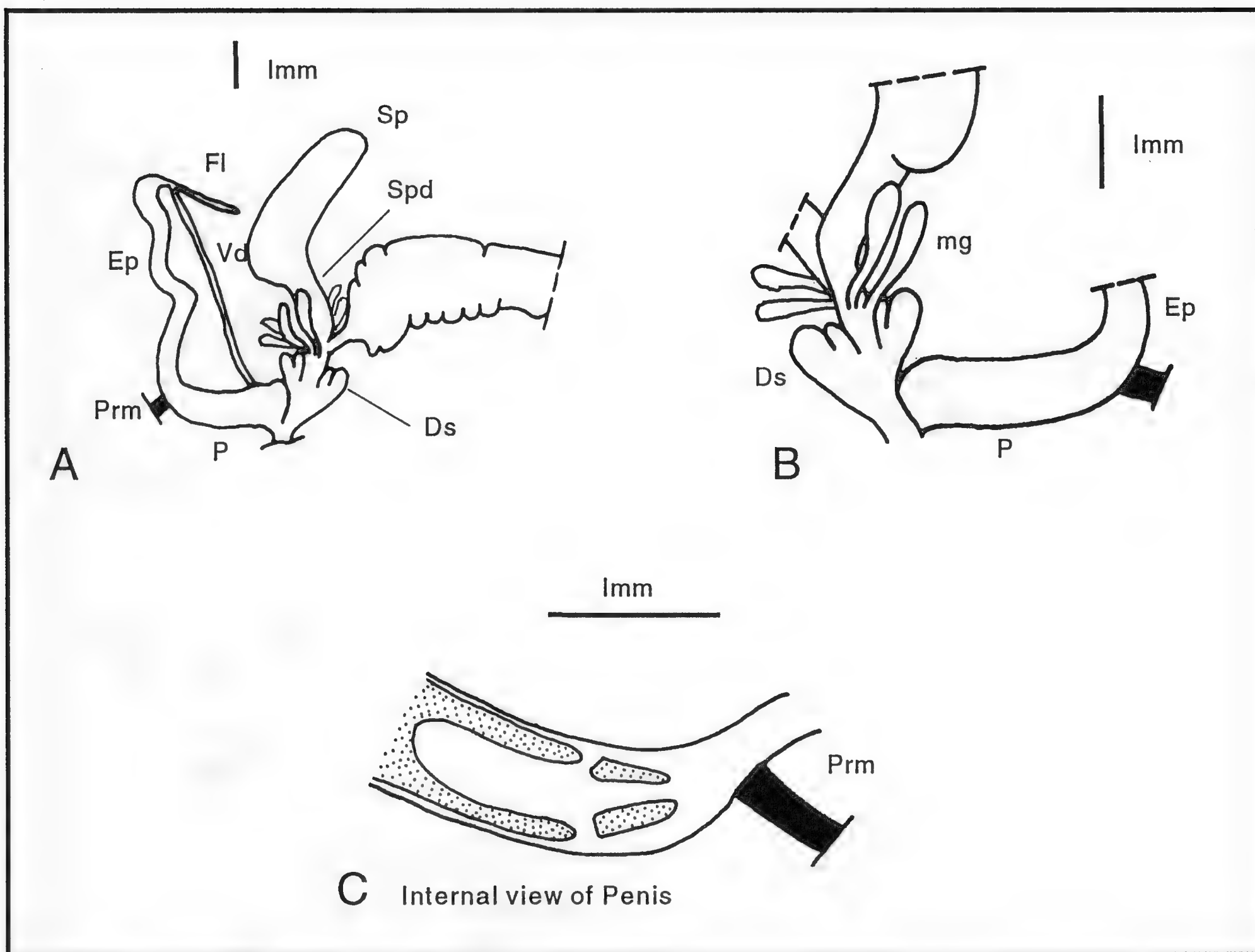


Fig. 4. A B C *Xerophila larbiana* (Pallary, 1927). Holyoak-Seddon Colln.: 0.5 km SE. of road at 12 km NNE. along road from Tounfite, E. Haut Atlas, Morocco (32°32'N, 5°11'W) (NMW.Z. 1993.051.16). A B General view of the genital apparatus; C Part of the penial complex with the distal penis open to show the penial papilla.

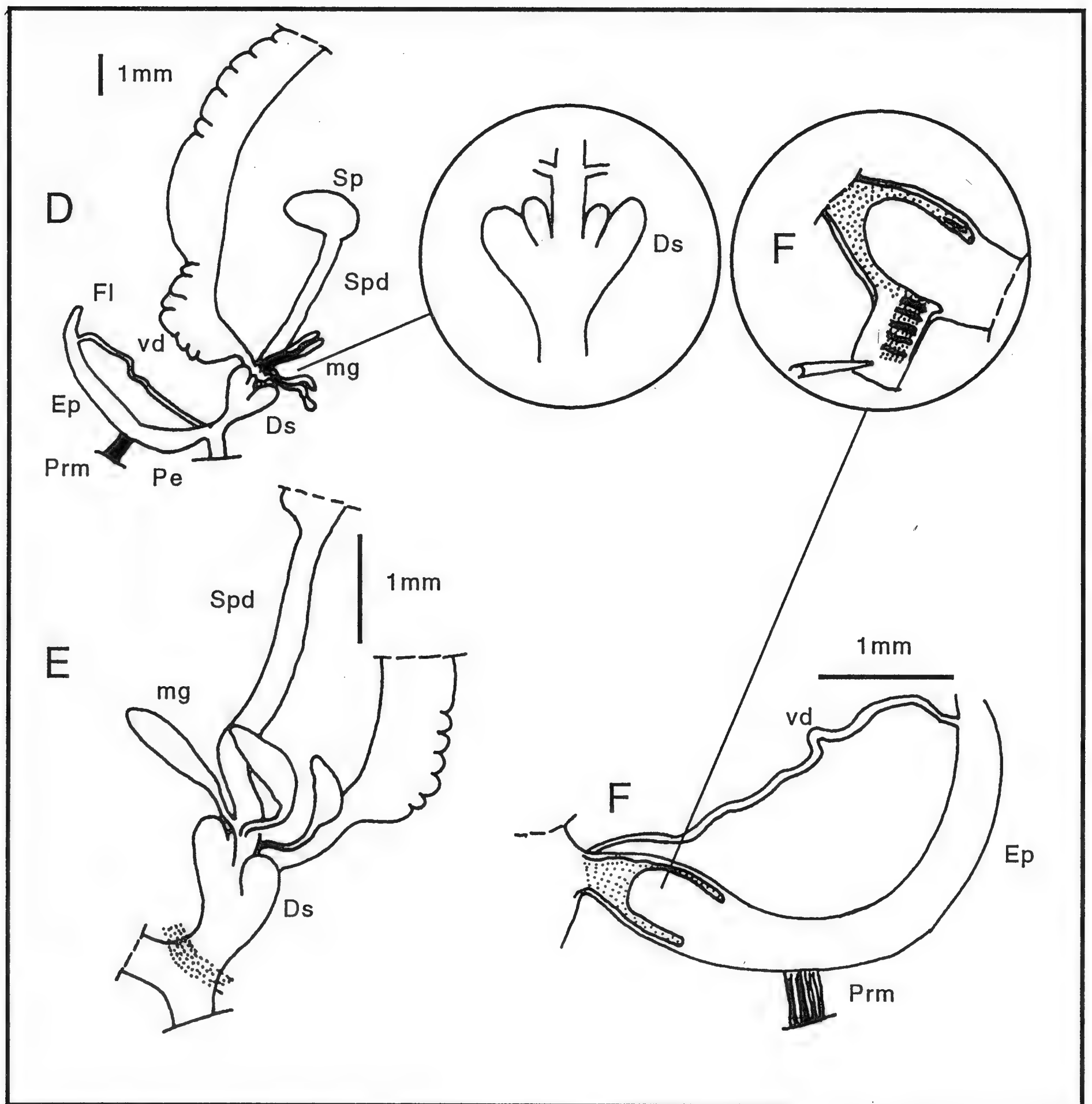
Abbreviations: Ds, Dart sacs; Dt, dart; Ep, Epiphallus; Fl, Flagellum; mg, vaginal digitiform glands [=vaginal mucus glands of some authors]; P, penis; rm, Penial retractor muscle; Sp, Spermatheca [= Bursa Copulatrix, or the gamolytic gland of some authors]; sd, Spermathecal duct (duct of Bursa Copulatrix); vd, Vas deferens; v, vagina.

duct of the Spermatheca opens. This duct is slender and very long (10-12 mm), more than four times the length of the spermatheca. The Spermatheca has bean-like shape.

**Range:** The specimens dissected were collected near to Taliouine, on high ground between the Anti Atlas and the Haut Atlas (30°30'N, 7°52'W). To examine the extent of the species range other material was examined from the adjacent sites in the Anti Atlas and Haut Atlas (Morocco); the following sites have shells which are comparable with the shells of the specimens dissected : Tizi-Mighert (S. of Tiznit), W. Anti Atlas; Smimou, W. Haut Atlas; Ammain, N. Anti Atlas; Assaka, W. Anti Atlas ; Mirleft, W. Anti Atlas; Tafingoult, W. Haut Atlas; Imi-n-Tanout, W. Haut Atlas. These localities would be indicative of a range covering the western part of the Haut Atlas (including the foothills of the coastal regions) through the Anti Atlas south to Goulimine (Fig. 6). However, given the problematic nature of species identification on shell characters alone, it is premature to confirm that these are the same species.

**Ecology:** The site was a rocky hillside of calcareous sandstone at 1360 m elevation. There was a sparse ground cover composed on herbs and grasses. The specimens were living on the shaded undersides of stones and on the soil surface underneath these stones. Other species





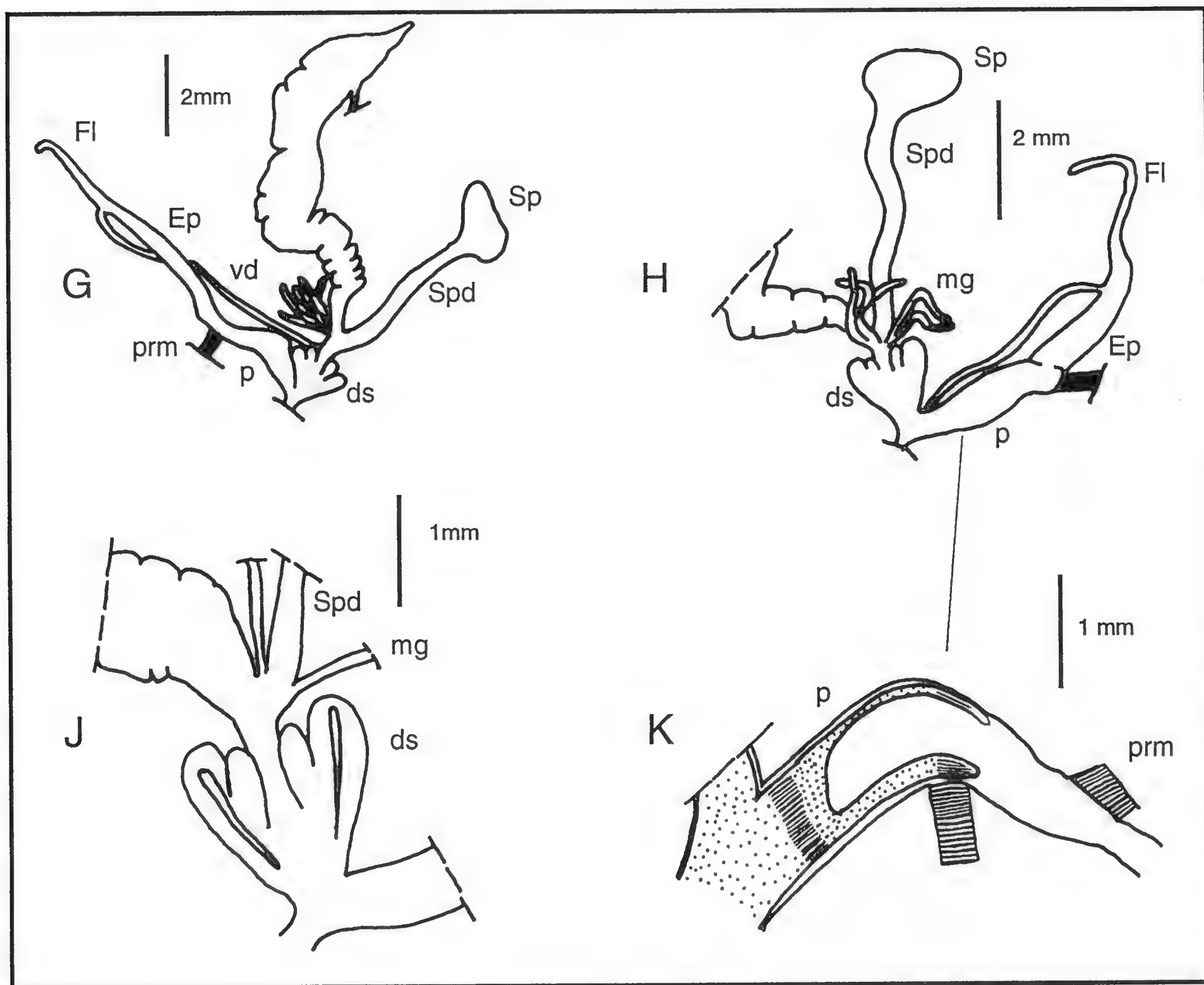
D E F *Helicopsis carrossei* (Pallary, 1936). Holyoak-Seddon Colln.: Ait-Saoun (SE. of Ouazzazate) Vallee du Draa, Morocco (Lat. 30° 43'N, Long. 6°36'N) (NMW.Z. 1993.051.17).

D General view of the genital apparatus; E Detail of the dart-sac complex; F Part of the penial complex with the distal penis open to show the penial papilla.

living at the site include *Helicopsis* (*Xeroleuca*) *turcica* (Holten, 1802), *Atlasica* sp. This species was found in the same habitats as *Helicopsis* (*Xeroleuca*) *turcica*.

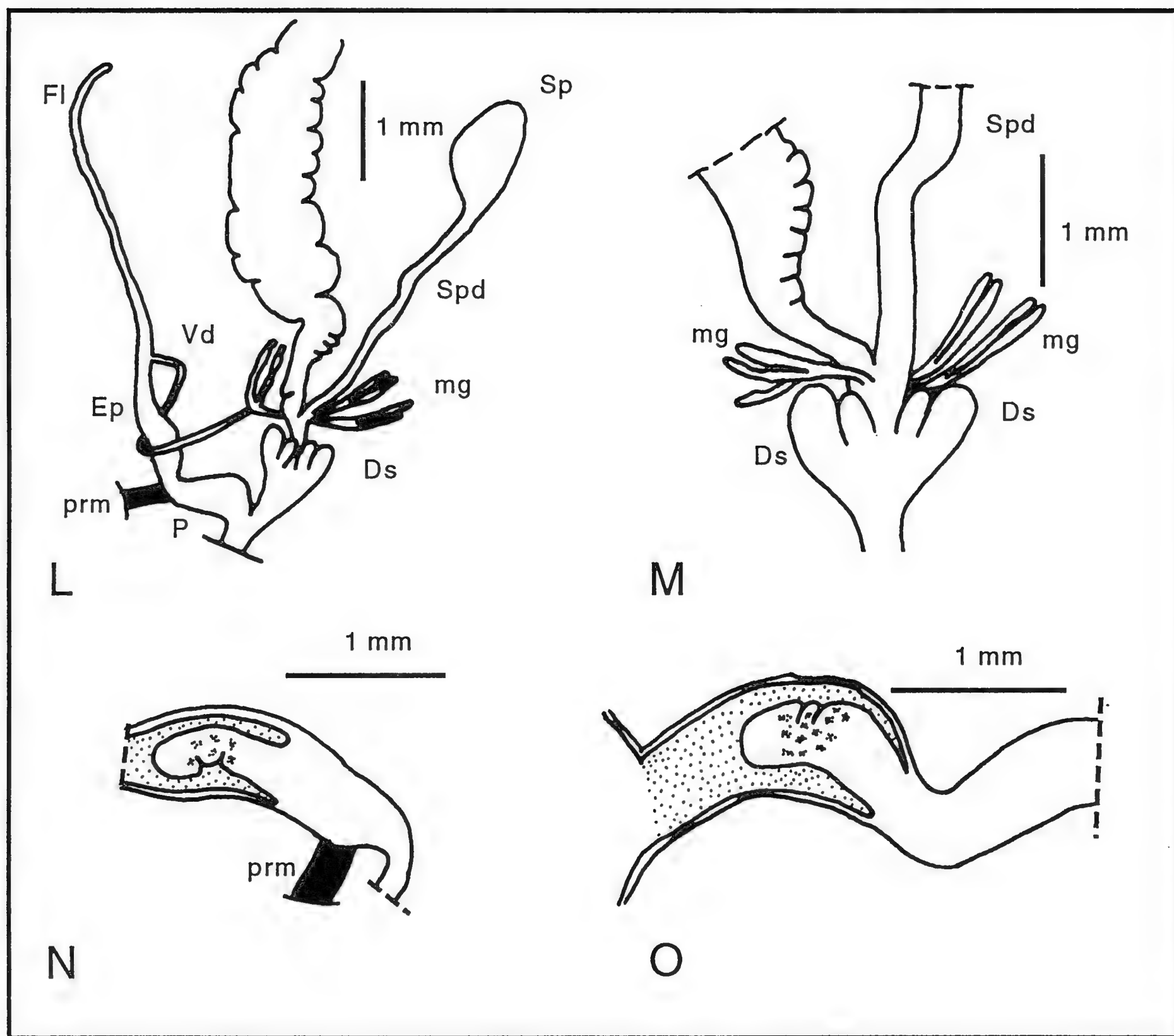
Other sites include rocky limestone slopes with scattered Argan trees and patches of succulent euphorbs (one at 1025 m elevation in the Anti Atlas; one at 210 m elevation in the Haut Atlas). There are subfossil shells from the region around Goulimine, at the southern limit of the records given here.

*Taxonomic and nomenclatural notes:* There are two similar species reported from the Marrakech region by Pallary (1898); *Xerophila cherifiana* and *Xerophila welschi*. The descriptions and illustrations of these species were found to be suitable for possible identification of our



G H J K *Helicopsis teboudensis* (Pallary, 1927). Holyoak-Seddon Colln.: by S 330 24 km W. along road from Ain Beni-Mathar [= Berguent], NE. Morocco (34°01'N, 2° 15'W) NMW.Z 1993.051.18 (Shells & Spirit material). GH General view of the genital apparatus; J Part of the penial complex with the distal penis open to show the penial papilla; K Detail of the dart-sac complex.

specimens from the Anti-Atlas. *Xerophila cherifiana* was collected by Olcese and passed to Pallary for identification. Pallary (1898) gives the type locality for this species as Marrakech, but indicates some uncertainty about this locality in Pallary (1921). In contrast the type locality for *Xerophila welschi* (collected by Ponsonby) was initially given as Maroc, but later amended to Marrakech (Pallary 1898, 1921). The size of the two species would suggest that *Xerophila cherifiana* (Breadth 11.5 mm, Height 7 mm) is the more suitable species name. Examination of the syntype of *Xerophila welschi* (BMNH. 1913.3.14.14.) shows that shells of this species are comparable with the material listed above except that our shells are generally bigger (*Xerophila welschi*: breadth 8.5 mm, height 6 mm). However, this shell looks slightly immature, and is comparable with shells which are not fully grown from sites in the Haut-Atlas. Thus, although there is a difficulty in establishing which name should be used for this species, the name *welschi* has been used as: (a) the shell material examined as part of this study was variable in size; (b) the type locality reported for *Xerophila welschi* is apparently more certain than *Xerophila cherifiana*; and (c) we were able to make comparison with the syntype of this species whereas material of *Xerophila cherifiana* has not been located in searching the collections in London, Cardiff or Paris, and there was initially some uncertainty as to whether the shell was a species of *Theba* or a "Helicellid" (Pallary 1898, 1904, 1921).



L M N *Helicopsis anflousiana* (Pallary, 1913). Holyoak-Seddon Colln. By P 31 2.5 km SSW. along the road from Tizin-Tichka (31°17'N, 7°22'W) NMW.Z 1993.051.22

LM General view of the genital apparatus; N O Part of the penial complex with the distal penis open to show the penial papilla.

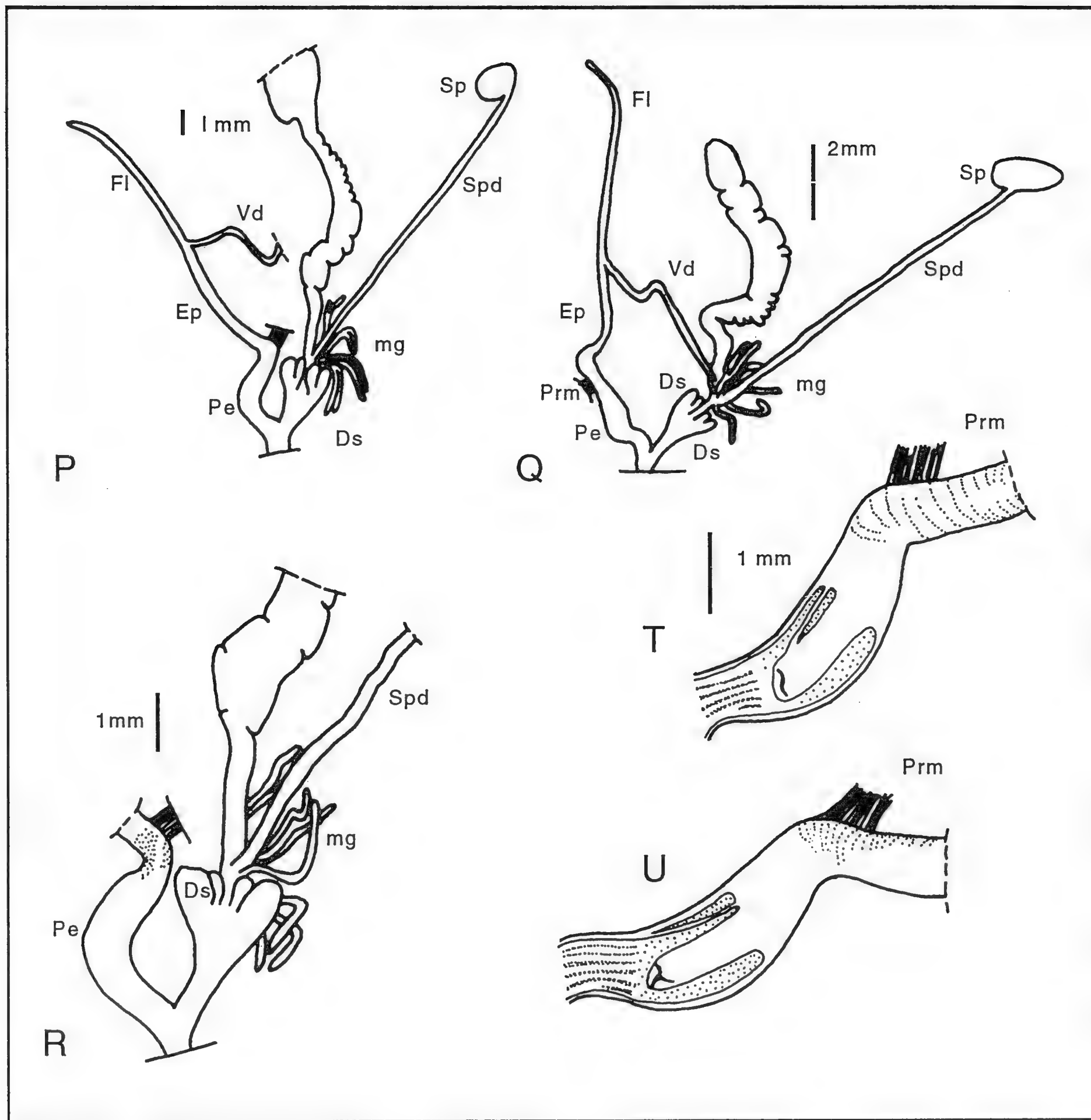
In order to stabilise the nomenclature we designate the specimen of *Xerophila welschi* (Natural History Museum, London BMNH. 1913.3.14.14) as a lectotype.

A similar looking species was also described from Marrakech, *Xerophila iae* (Pallary, 1898) [replacement name for *Helix richardii* (Ponsonby in Kobelt, 1889) Fig. 5 D] but this species is taller with a more defined suture and a reflected lip. There is no anatomical data for this taxa although Richardson (1980) placed the species in the synonymy of "*Cernuella*" *dautezi* (Kobelt) from the Gibraltar region without any supporting statements; this requires further investigation.

#### COMPARATIVE DIAGNOSES OF THE ABOVE SPECIES

*Helicopsis larbiana* and *H. carrossei* are rather similar in shell characters having a medium-sized shell, with fine to medium ribbing and a mouth which descends slightly. However, the genital anatomy differs in that *H. larbiana* shows the shortest spermathecal duct and





P Q R S T U *Helicopsis* cf. *welschi* (Pallary, 1898). Holyoak-Seddon Colln. By P32 c. 7 km SE. of Taliouine, Morocco (30°30'N, 7°52'W) NMW.Z 1993.051.24

P Q General view of the genital apparatus; R Detail of the dart-sac complex; S T U Part of the penial complex with the distal penis open to show the penial papilla.

proportionally the largest spermatheca, whereas *H. carrossei* has the shortest flagellum. There are also differences in the penial papilla. *H. larbiana* has a more complicated penial papilla which resembles that of *H. striata*. The penial papilla of *H. carrossei* is simple and has characteristic folds on the interior of the penis wall.

The shell of *H. teboudensis* differs from the other species in having a medium to large size shell with more broad and widely spaced ribs and the mouth does not descend. In the genital anatomy the proportions of the flagellum and the spermathecal duct are larger than those of *H. larbiana* and *H. carrossei* but smaller than *H. anflousiana* and *H. cf. welschi*. The penial papilla also differs from the other species in being simple and there are fine folds on the proximal part of the penis wall.

The shell of *H. anflousiana* differs from all the other species in having small slightly curved hairs. The genital anatomy of this species has a proportionately long flagellum and a longer

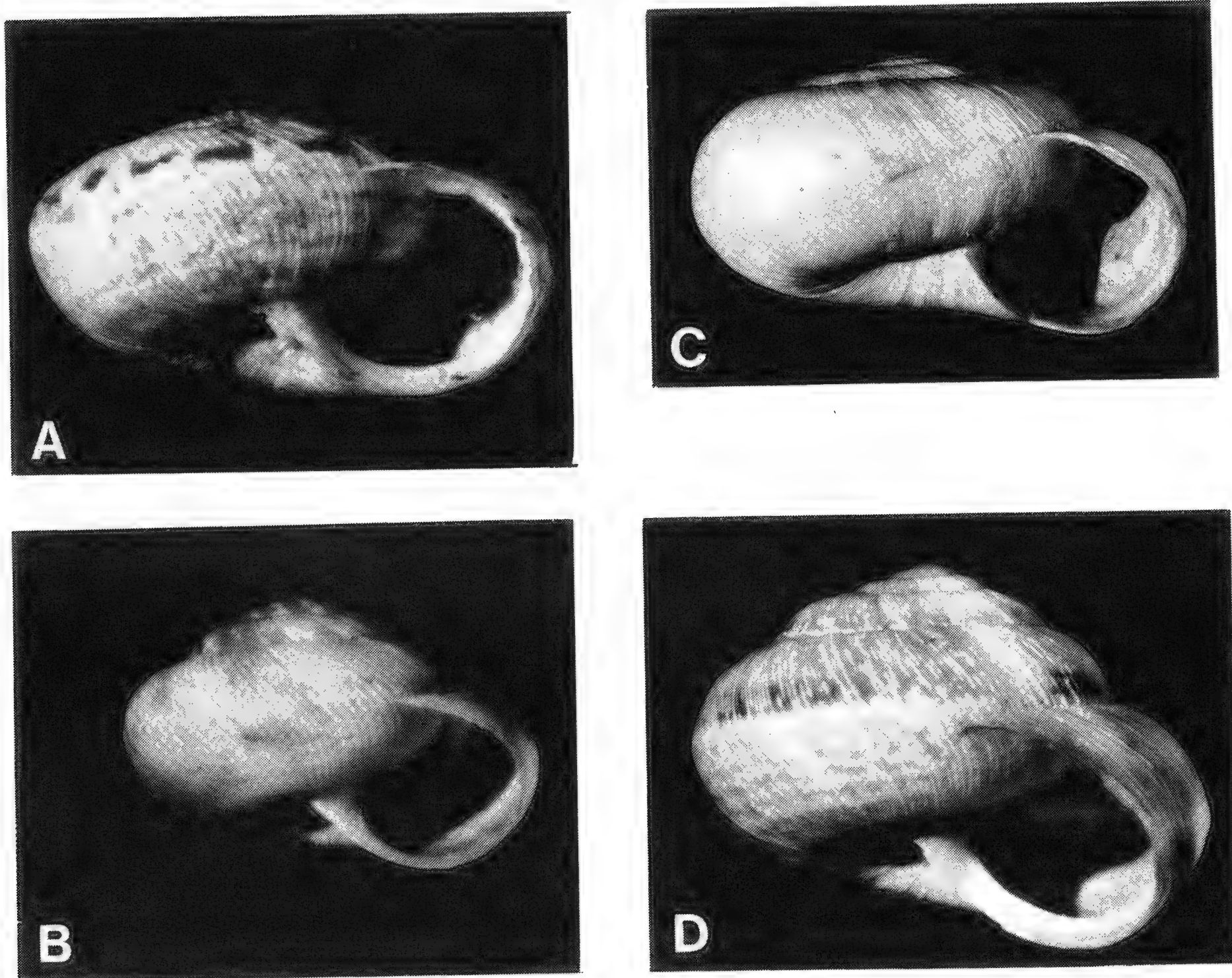


Fig. 5 Comparative shell figures. A *Polytrichia thomsoni* (Pallary, 1927). Syntype El Hajeb, Morocco (Melvill-Tomlin Coll. NMW. 1955. 158.1594). B *Xerotrichia ourebasiana* Pallary, 1927 Marrakech, Morocco (Melvill-Tomlin Coll. NMW. 1955. 158.1595). C *Xerophila edrissiana* (Pallary, 1918) (Melvill-Tomlin Coll. NMW. 1955. 158.1601). D *Cernuella richardi* Kobelt (= *Cernuella* Ioe (Pallary, 1898) Type Cabo Negro, Morocco Ponsonby, Natural History Museum (BMNH. 1913.3.14.13).

spermathecal duct than all species except *H. cf. welschi*. The penial papilla has a shape which differs from all the other species described above, simple but with folds.

*H. cf. welschi* has the largest shell of these species, with a very shallow suture, and a reflected columellar margin. By comparison with the above species, *H. cf. welschi* has the proportionately longest flagellum and the longest spermathecal duct. The penial papilla is simple, but it is the only species which has a pilaster linking the papilla to the penis wall, although the position of this pilaster is variable.

## DISCUSSION

### *Taxonomy of the genus*

The anatomy of type species *Helicopsis striata*, has been studied from different parts of its range and show that the external characters of the genitalia are constant (e.g. Hesse 1934, Schileyko 1978, Giusti & Manganelli 1989, Hausdorf 1990, Giusti *et al.* 1992). The five species analysed in this paper have genitalia which are similar to the type species of the genus, in having two outer dart-sacs containing darts with two similar-sized inner accessory

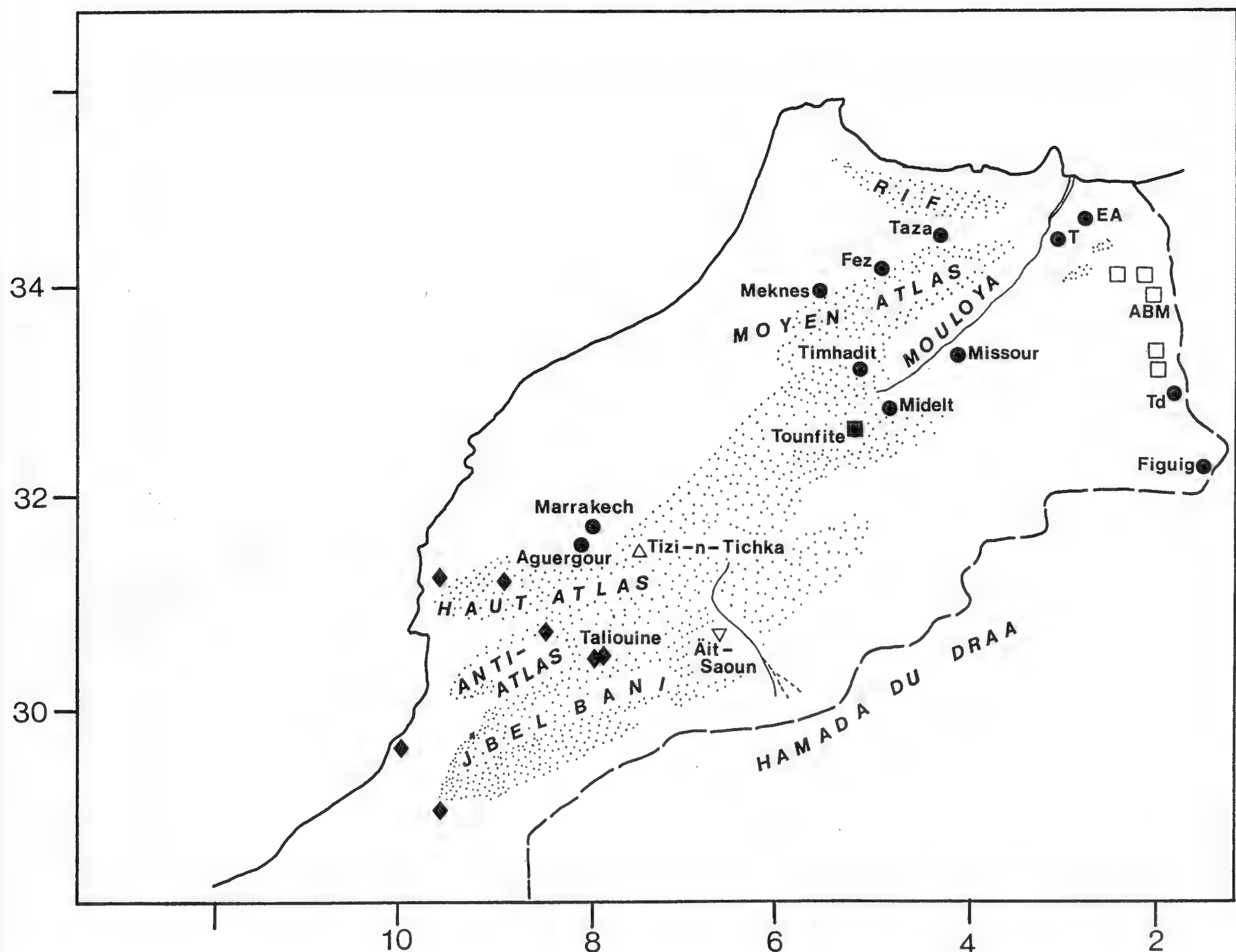


Fig. 6 Map of Morocco showing sites mentioned in the text. Shaded areas designate the mountain regions. Symbols for species: *H. larbiana*, Filled squares; *H. carrossei*, Open inverted triangles; *H. teboudensis*, Open squares; *H. anflousiana*, Open triangle; *H. welschi*, Diamonds.

sacs on either side of the vagina. The other species which have recently been described from Cyprus, Greece and Turkey also show the same characters (Hausdorf 1990, Gittenberger 1991). These characters differentiate the genus *Helicopsis* from the recently revised genus *Xerotrichia* (Hausdorf 1988, Gittenberger 1991) which has two dart-sacs with two small accessory sacs which are hardly distinguishable. Latterly, Giusti *et al.* (1992) described a new genus *Helicotrichia* which seems to be close to *Helicopsis*. The five species described above differ from this new genus in the absence of the glandular tissue at distal end of the penis wall and the absence of a lateral pilaster running alongside the entire length of the penial papilla.

Examination of the penial papilla of these five Moroccan species showed that one species, *H. larbiana*, has a similar structure to that of *Helicopsis striata* (Schileyko 1978, Giusti *et al.* 1992) but none of the other species showed the same structure. Schileyko (1978) also found one species of *Helicopsis* from Russia with a different structure of penial papilla which is quite simple like some of these Moroccan species. In view of these data it may be that the structure of the penial papilla is variable within the genus *Helicopsis*.

Hausdorf (1990) showed that *Helicopsis gittenbergeri*, had a proportionally long flagellum, and suggested that the length of the flagellum could be an important taxonomic character. Our results show that this character is more frequent as two more species of *Helicopsis* (from Morocco) also have a proportionally long flagellum.

The species of the subgenus *Helicopsis* (*Helicopsis*) differ from those of the subgenus



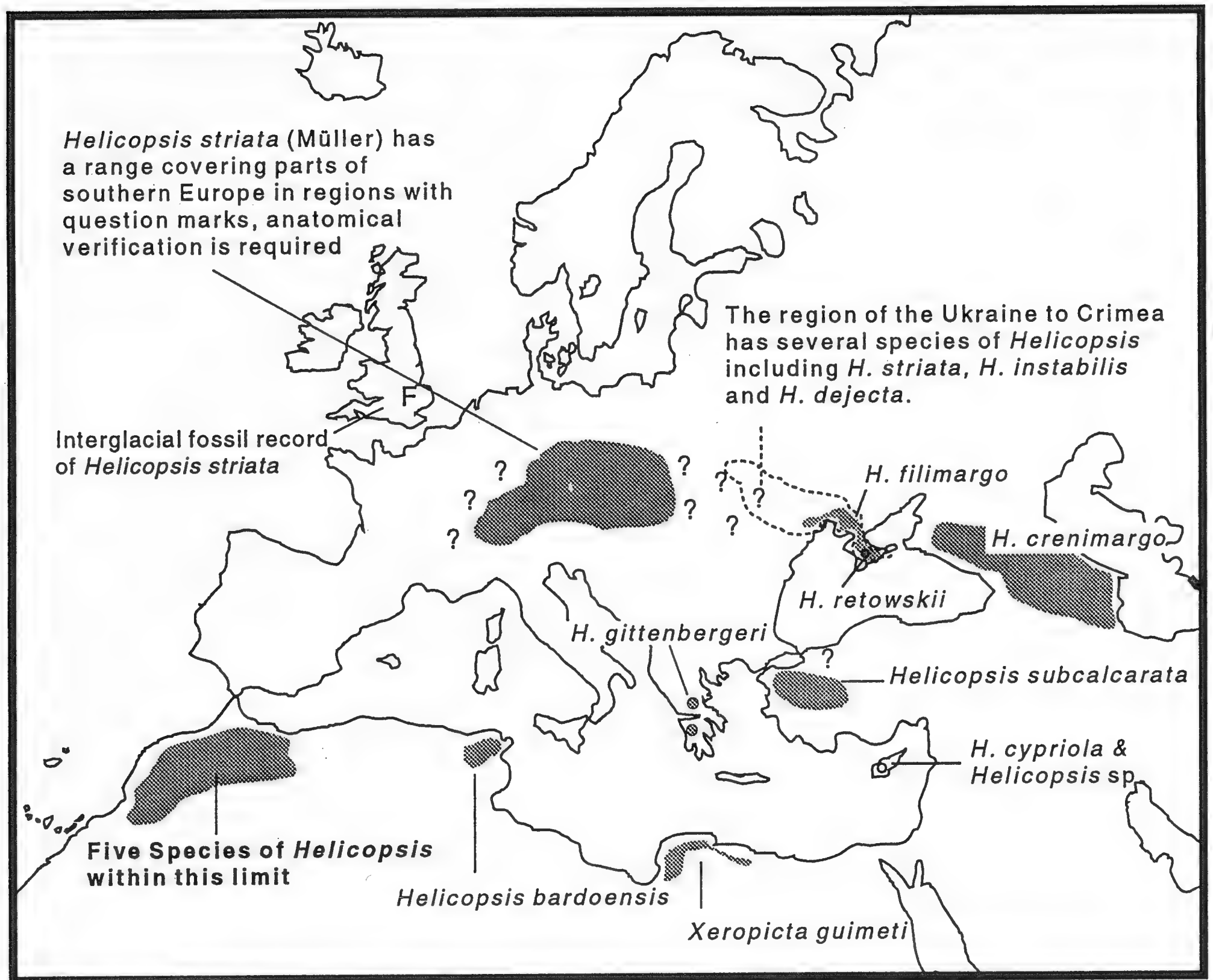


Fig. 7 Map of Europe and NW. Africa showing the disjunct distribution of the genus *Helicopsis*.

*Xeroleuca* in both shell characters (usually smaller size, thinner shells, ribbed, not granular, shell sculpture) and anatomical characters (proportionately larger dart-sacs; larger darts which fill the inner space of the sacs; absence of a free vaginal neck) (Aparicio *et al.* 1991).

#### *The distribution of the genus*

The range of genus *Helicopsis* (*Helicopsis*) was previously known to extend through central and eastern Europe. It is therefore surprising to find five more species of *Helicopsis* (*Helicopsis*) and two of *Helicopsis* (*Xeroleuca*) in Morocco (Aparicio *et al.* 1991), where the majority of them are likely to be endemic. This represents a considerable range extension for the genus, since the majority of species are described from SE. Europe (Fig. 7).

Before discussing the origins of this apparently disjunct distribution, one needs to consider whether this gap is related to a lack of knowledge about the intervening region. Recent work in Greece, Turkey and Cyprus (Hausdorf 1990, Gittenberger 1991) increased the number of species of *Helicopsis* from southern Europe, adding to those previously described by Schileyko (1978) from European Russia. At present there is very little anatomical information for the Helicellinae from much of northern Africa. Brandt (1959) did not find any species of *Helicopsis* (*Helicopsis*) in Cyrenaica and there are none yet known from Israel or the adjacent countries (Forcart 1976). There are also species in other genera which have similar shell characters to *Helicopsis*, leading to confusion where identification is based

only on these characters (Kerney & Cameron 1979, Hausdorf 1990, Gittenberger 1991, 1993). Thus, although there are poorly known regions and problems with species identification, the present evidence from the eastern end of the Mediterranean suggests that the apparently disjunct range may be real.

Giusti & Manganelli (1984) described several examples of disjunct distribution patterns of genera present in NW. Africa. They argued that many of these patterns related to dispersal through the movement of microplates carrying the local molluscan fauna from the SE. European region towards NW. Africa during the Miocene period. These taxa provided the ancestors for further speciation.

There are other possible causes of disjunct patterns. One could also speculate that this wide disjunction of ranges in *Helicopsis* results from fragmentation of a formerly more continuous range. There are Late Pliocene fossil records of shells from Central and SE. Europe which have been placed in the genus *Helicopsis* (Likharev & Rammelmeier 1962, Zilch 1960: 671). More recent Pleistocene records of *Helicopsis striata* extend from central Europe to the British Isles (Sparks 1953). The latter records point to a more continuous range for at least one species of *Helicopsis*. It is not unreasonable to suggest that repeated occurrences of very cold climates led to changes in the distribution patterns of the flora and fauna with the species of *Helicopsis* (*Helicopsis*) becoming isolated in N. Africa as the result. Similar disjunct distribution patterns are also seen with other genera and a broadly comparable distribution pattern occurs with *Leiostyla s.l.* This genus has widely separated main centres of species abundance in the Caucasus and in the Madeiran Islands (Pilsbry 1922-26). In this case it is clear that the pattern of distribution results from range fragmentation, since the genus is known from Tertiary fossils in central Europe and because *L. anglica* (and closely allied forms) still occupy some of the intervening regions (Seddon, Tattersfield & Holyoak 1993).

To investigate this pattern further, studies are needed of both living faunas and Pleistocene sites throughout the Mediterranean regions. It is probable, that as taxonomic investigations clarify the generic status of Helicidae in NW. Africa, further species *Helicopsis* may be found across this region, which might provide a more continuous pattern. In this case one could speculate, based on the present distribution of the genus (which is apparently absent in Spain and S. Italy and the supposed N. Africa distribution), that the genus evolved from some point in south European Russia, through two areas to the North and South of the Mediterranean Sea. Other studies of NW. African faunas would ascertain the frequency with which the disjunct distribution pattern of *Leiostyla*, and apparently also *Helicopsis*, is repeated in other genera.

#### ACKNOWLEDGEMENTS

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# THE RISSOININAE (GASTROPODA: RISSOIDAE) OF THE PITCAIRN ISLANDS, WITH THE DESCRIPTION OF TWO NEW SPECIES<sup>1</sup>

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(Accepted for publication, February 19th, 1994)

*Abstract:* This paper reviews the Rissoininae from the four islands that comprise the Pitcairn Group. The material was collected during the Sir Peter Scott Commemorative Expedition to the Pitcairn Islands between October and December 1991. Twelve species belonging to this subfamily are reported, including two undescribed taxa. The well-known species are listed with synonymies and the poorly known species are (re)described and illustrated. The shells of two new species, *Rissoina* (*Rissoina*) *fratercula* and *Rissoina* (*Rissoina*) *schubelae*, are described in detail. The biogeographical relationships of the fauna are briefly discussed.

*Key words:* *Rissoina*, *Zebina*, *Stosicia*, Ducie Atoll, Oeno Atoll, Henderson Island, Pitcairn Island.

## INTRODUCTION

The Pitcairn Islands are of particular biogeographical importance because of their isolation, peripheral location and unusual physiography. They are the easternmost islands on the Pacific Plate, lying south of the Tropic of Capricorn. They are located towards the southeastern edge of the Indo-West Pacific province, some 390 km east of their nearest neighbour, Temoe Atoll in the Tuamotu-Gambier Islands, and 1570 km west of Easter Island and Sala y Gomez on the Nazca Plate. The four islands that comprise the Pitcairn Group differ markedly in physiography. Ducie and Oeno are small atolls of very different character. Pitcairn, the only island in the group still inhabited, is volcanic and has steep cliffs but very little reef development. Henderson is an uplifted atoll with moderate reef development.

Studies of the marine fauna of the Pitcairn Group have been sporadic and uneven. The unevenness relates not only to the intensity of research undertaken on each island but also to the coverage of the different groups of organisms studied. Some information does exist on the marine molluscan faunas (Rehder & Randell 1975, Rehder & Wilson 1975, Rehder *in* Fosberg *et al.* 1983, Paulay 1989), but this is sketchy and knowledge of many of the small taxa entirely lacking. One of us (RCP) was invited to join the penultimate phase of the Sir Peter Scott Commemorative Expedition which visited the Pitcairn islands in 1991–2 (Anon. 1992). During this Expedition particular attention was devoted to the collection of many of these small neglected groups. In this paper we provide the first account of the Rissoininae from the Pitcairn Islands. No material belonging to this subfamily had previously been reported from these islands and the following account is therefore based exclusively on specimens collected during this Expedition.

<sup>1</sup> Sir Peter Scott Commemorative Expedition, Contribution No. 15.

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## SAMPLING SITES

Details of the sampling sites are listed below for each island. Although many specimens were found in the field, the majority were extracted from sediment samples sent back to Britain for laboratory analyses.

**Ducie Atoll** (24°39'S 124°48'W). Ducie is a small atoll about 4 km in diameter, with one larger (Acadia) and three smaller islets surrounding a central lagoon up to 12 m deep. It is not only the easternmost island on the Pacific Plate but also the southernmost atoll in the world. The marine habitats of Ducie have been described by Rehder & Randall (1975). Sands and fine sediments are scarce on the fore reef and reef flat of Ducie and this is reflected in the composition of the Acadia motu, which consists almost entirely of coral rubble and shells (mostly *Turbo argyrostomus*). Cemented slabs of coral limestone were also common. In general, shells of small taxa were not plentiful and the specimens were all very worn. Sediment samples were collected from the beaches on both the lagoon and seaward side of the motu.

**Henderson Island** (24°22'S 128°20'W). Henderson is the largest island in the group with an area of 37 km<sup>2</sup>. It is an uplifted atoll with a peripheral ridge, reaching about 30 m high, encircling a flat central basin about 22 m above sea-level, representing the site of the former lagoon. The uplift of Henderson is thought to have been relatively recent (less than 1 Ma) and has been attributed to lithospheric flexure around Pitcairn (McNutt & Menard 1978). A brief description of the modern reefs of Henderson is given by Spencer & Paulay (1989). In contrast to Ducie, the fore reef on Henderson is relatively narrow, has abundant soft sediments and supports low coral cover. Adjacent to the North, North-west and East Beaches there is an extensive reef flat platform, from 40–90 m wide, between the low tide mark and the reef margin. At high tide the flat is covered to a depth of about 1–1.5 m. At low tide large areas of smooth, sand-scoured reef pavement are exposed, with small holes and channels running perpendicular to the shore (Anon. 1992). All the Henderson material described here was collected from the three beaches. Additional sediment samples were collected from a water-depth of 12 m off the East Beach. In general, material from the more sheltered North-west and East Beaches was better preserved than that from the more exposed North Beach.

**Oeno Atoll** (23°56'S 130°45'W). In contrast to Ducie, Oeno is located at the western end of the group and is larger, about 4 km in diameter, and consists of a small central island surrounded by a lagoon. The lagoon is shallow throughout (1.5–3 m) and has an undulating bottom of rubble and sand with scattered reefs (Devaney & Randall 1973). All the material from Oeno studied here was collected on the spit, now joined to the principal motu.

**Pitcairn Island** (25°04'S 130°06'W). Pitcairn is a high (347 m), small (4.5 km<sup>2</sup>), volcanic island that rises precipitously from the ocean. It formed between 0.46–0.93 Ma ago (Duncan *et al.* 1975), and is the southernmost island in the group. Unlike the other islands, it lacks substantial reef development. The coral reefs that do exist are small, isolated and generally confined to depths of over 20 m. A brief description of the underwater topography and habitats of Pitcairn are given by Devaney & Randall (1973). All the material from Pitcairn studied here was collected from the beach at Down Rope. In comparison to material from Henderson and Oeno, it was very badly worn.

ABBREVIATIONS

BPBM	Bernice P. Bishop Museum, Honolulu, Hawaii
KBIN	Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels
LACM	Los Angeles County Museum, Los Angeles
UMZC	University Museum of Zoology, Cambridge

SYSTEMATIC REVIEW

***Rissoina (Rissoina) ambigua*** (Gould, 1849)

*Pyramidella ambigua* Gould, 1849: p. 118.

*Rissoina (Rissoina) ambigua* (Gould): Ponder, 1985: p. 79, figs. 53 B 129 E–G.

*Material examined*: Oeno Atoll, Nov. 1991 (57 specimens); Henderson Island, East Beach (7 specimens), North-West Beach (22 specimens), Oct–Dec. 1991; all coll. R. C. Preece (UMZC).

*Geographical distribution*: Tropical Indian Ocean to central Pacific.

***Rissoina (Rissoina) costata*** A. Adams, 1851  
(Pl. 1, Figs. 3,6)

*Rissoina costata* A. Adams, 1851: p. 266.

*Rissoina turricula* Pease, 1860: p. 438. See also Leal & Moore 1989: p. 142, figs. 10–11.

*Rissoina (Rissoina) turricula engleri* Rehder, 1980: p. 26, pl. 5, fig. 6.

*Material examined*: Pitcairn Island (>50 specimens); Oeno Atoll, (39 specimens), Nov. 1991; all coll. R. C. Preece, (UMZC).

*Geographical distribution*: Central Pacific, as far east as Easter Island, as far south-west as the Kermadec Islands, as far north as the Hawaiian Islands and as far west as the Marshall Islands.

***Rissoina (Rissoina) heronensis*** (Laseron, 1956)  
(Pl. 3, Fig. 1)

*Fractoralla heronensis* Laseron, 1956: p. 399, figs. 30–31.

*Material examined*: Henderson Island, East Beach (14 specimens), North-west Beach (24 specimens), Oct–Dec. 1991; Oeno Atoll (25 specimens), Nov. 1991; all coll. R. C. Preece, (UMZC).

*Geographical distribution*: From the Cocos Islands in the Indian Ocean to Pitcairn in the central Pacific

***Rissoina (Rissoina) fratercula*** n.sp.  
(Pl. 1, Figs. 1–2, 4–5)

*Description*: Shell (Pl. 1, Figs. 1–2) small (up to 3.1 mm), elongate-conical, slightly translucent, rather solid.

Protoconch (Pl. 1, Fig. 4): of non-planktotrophic larval type, of about 1 smooth whorl



with early portion strongly deflected; transition to teleoconch abrupt with a weakly thickened, slightly to moderately sinuous margin.

Teleoconch: comprised of about 6 whorls; whorls of the spire relatively convex, slightly shouldered below moderately impressed, weakly undulating sutures; last whorl very weakly convex, strongly contracted near base.

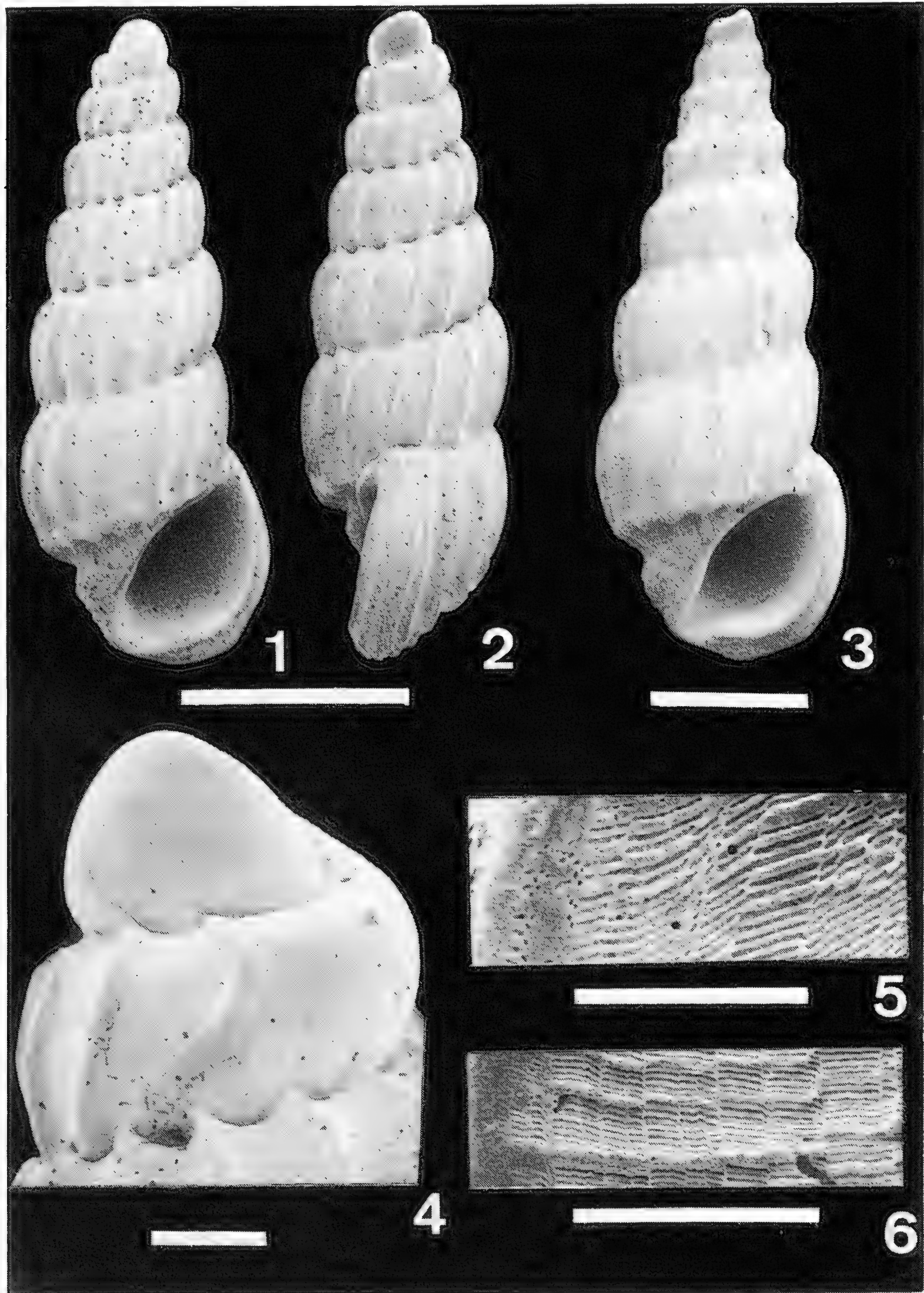


Plate 1

Figs. 1–2, 4–5: *Rissoina (Rissoina) fratercula* n.sp., Oeno Atoll. 1, 5: Apertural view (Fig. 1) and microsculpture (Fig. 5) of holotype (UMZC, 120741). 2. Lateral view of paratype no 13 of *Rissoina (R.) fratercula* (KBIN). 4. Protoconch of paratype no 11 of *Rissoina (R.) fratercula* (KBIN IG. 28.034).

Figs. 3, 6: *Rissoina (Rissoina) costata* A. Adams, 1851, Oeno Atoll: apertural view of shell (Fig. 3) and microsculpture (Fig. 6).

Scale bars: Figs. 1–3: 1 mm; Figs. 4, 6: 100  $\mu$ m; Fig. 5: 50  $\mu$ m.

THE RISSOININAE OF THE PITCAIRN ISLANDS, WITH DESCRIPTION OF TWO NEW SPECIES

Axial sculpture of weak, narrow, widely spaced, weakly opisthocline ribs; interspaces rather wide, moderately deep, with fine, widely spaced spiral threads (Pl. 1, Fig. 5).

Last whorl with a moderately prominent basal spiral fold, intersected by abapical part of axial ribs.

Aperture lenticular; inner lip very narrow; outer lip with a prominent, moderately opisthocline varix immediately behind edge, bearing about 4 to 5 weak, densely spaced axial riblets; anterior channel short, rather wide and shallow.

Shell colour: white throughout.

Shell dimensions: see table 1.

Operculum, radula and animal unknown.

*Type material and type locality:* Holotype: empty shell from Oeno Atoll (UMZC,120741), Pitcairn Islands Scientific Expedition, Nov. 1991, coll. R. C. Preece; 10 measured and 83 non-measured paratypes from type locality in UMZC (120741.A-J); 3 paratypes from type locality in KBIN (IG. 28.034), and 6 paratypes in BPBM (BPBM 248737).

*Additional material examined:* Henderson Island, East Beach (3 specimens), North-West Beach (10 specimens); Pitcairn Island (1 specimen); all coll. R. C. Preece, Oct.–Dec. 1991 (UMZC).

*Geographical distribution:* Pitcairn Islands.

TABLE 1

*Rissoina (Rissoina) fratercula* n.sp. Shell dimensions and number of ribs. (L: shell length; Ls: spire length; D: diameter of last whorl; D<sub>n-1</sub>: diameter of penultimate whorl; Dpr: diameter of protoconch; no. ax: number of axial ribs on last whorl; no. axp: number of axial ribs on penultimate whorl; no. whorls: number of teleoconch whorls).

L (mm)	Ls (mm)	D (mm)	D <sub>n-1</sub> (mm)	Dpr. (mm)	no. ax	no. axp	no. whorls
<b>Oeno Atoll:</b>							
Holotype (UMZC, 120741): Pl. 1, Figs. 1, 5)							
2.7	1.8	1.0	0.9	0.33	15	17	5½
Paratypes (all in UMZC except where stated)							
3.1	2.1	1.1	0.9	0.32	14	16	6
3.0	2.0	1.1	0.8	0.33	14	15	6
2.9	2.0	1.0	0.9	0.33	15	17	5½
2.9	2.0	1.0	0.8	0.34	15	15	5½
2.9	2.0	1.1	0.9	0.33	15	15	5¾
(KBIN, IG. 28.034)							
2.8	1.9	1.1	0.9	0.33	14	15	5½
2.9	2.0	1.1	0.9	0.31	14	15	5¾
2.9	1.9	1.1	0.9	0.32	16	16	5½
(KBIN, IG. 28.034): Pl. 1, Fig. 2							
2.7	1.8	1.1	0.8	0.33	13	15	5¼
2.7	1.7	1.1	0.8	0.30	14	16	5
(KBIN, IG. 28.034): Pl. 1, Fig. 4							
2.6	1.7	1.0	0.8	0.33	15	16	5
2.5	1.6	1.0	0.8	0.33	15	17	5
2.5	1.6	1.0	0.8	0.35	14	15	5
<b>Henderson Island (UMZC)</b>							
2.7	1.8	1.0	0.9	0.35	11	14	5
2.5	1.7	1.0	0.8	0.32	11	13	5¼

*Variation:* *Rissoina (Rissoina) fratercula* appears to be very uniform in shell characters.

*Affinities and differences:* *Rissoina (Rissoina) fratercula* is very similar in shell characters to *R. (R.) costata* A. Adams, 1851, but differs by its smaller shell [2.8 mm (n = 16) vs. 4.5 mm (n = 33)], by its more elongate shell shape and by the less prominent spiral (micro)sculpture. The protoconch of both species is identical in shape, but the fine spiral threads on the last whorl of the protoconch, which can be seen in fresh specimens of *R. (R.) costata*, appear to be absent in *Rissoina (Rissoina) fratercula*.

*Etymology:* Fraterculus (Latin: Little brother) refers to the similarity to *R. costata*, from which it differs in being markedly smaller.

***Rissoina (Rissoina) tenuistriata* Pease, 1867**

*Rissoina tenuistriata* Pease, 1967: p. 295, pl. 24, fig. 30.

*Rissoina (Zebinella) tenuistriata* Pease: Cernohorsky 1978: p. 46, pl. 12, fig. 3.

*Material examined:* Henderson Island, East Beach, Oct-Dec. 1991, coll. R. C. Preece, 1 specimen (UMZC).

*Geographical distribution:* Tropical Indo-West Pacific, from the E. African coast to Pitcairn.

*Remarks:* The Henderson material consists of only one, large juvenile specimen (shell length: 6.6 mm) which has an identical protoconch and early teleoconch whorls to typical specimens of this species from other localities.

This species is also reported from the Tuamotu Archipelago (type locality of *R. tenuistriata* and pers. obs. of material in LACM).

***Rissoina (Rissoina) schubelae* n.sp.**

(Pl. 2, Figs. 1–5)

*Description:* Shell (Pl. 2, Figs. 1–3): small to rather large (shell length ranging from 3.1 to 6.2 mm, n = 18), elongate-conical to strongly elongate.

Protoconch (Pl. 2, Fig. 4): consists of 1 rather depressed whorl, of non-planktotrophic larval development; transition to teleoconch abrupt with a non-thickened, weakly sinuous margin.

Teleoconch: whorls of spire very weakly convex to almost rectilinear with weakly to moderately impressed, slightly undulated sutures; last whorl moderately convex, weakly contracted near the base, or not contracted in some specimens.

Axial sculpture of rather narrow, weak, regularly and rather distantly spaced, weakly opisthocline ribs, separated by wider and shallow interspaces; axial ribs sometimes weaker and more numerous on last whorl and almost continuous to peristome.

Spiral sculpture absent on spire whorls, apart from some (2 to 3) weak threads just above sutures of abapical whorls; abapical half of last whorl with weak spiral threads, intersecting axial ribs.

Microsculpture (Pl. 2, Fig. 5) of extremely fine spiral striations between axial ribs.

Aperture: lenticular; inner lip very narrow and thin, apart from moderate swelling near anterior end; anterior channel shallow, narrow, short; posterior channel short; inner lip moderately thickened internally, externally with weak, rather narrow, moderately opisthocline varix, latter bearing ca. 5 closely spaced axial ribs.

Operculum, radula and anatomy: unknown.

Shell dimensions: see table 2.



*Variation:* This species shows considerable variation with respect to both the shell shape and shell dimensions (cf. description). In some specimens, the adapical spire whorls are strongly deflected with respect to the abapical spire whorls and the last whorl. The contraction near the shell base can be more or less prominent.

*Type material and type locality:* Holotype (UMZC, 120742) and 15 paratypes from Oeno Atoll,

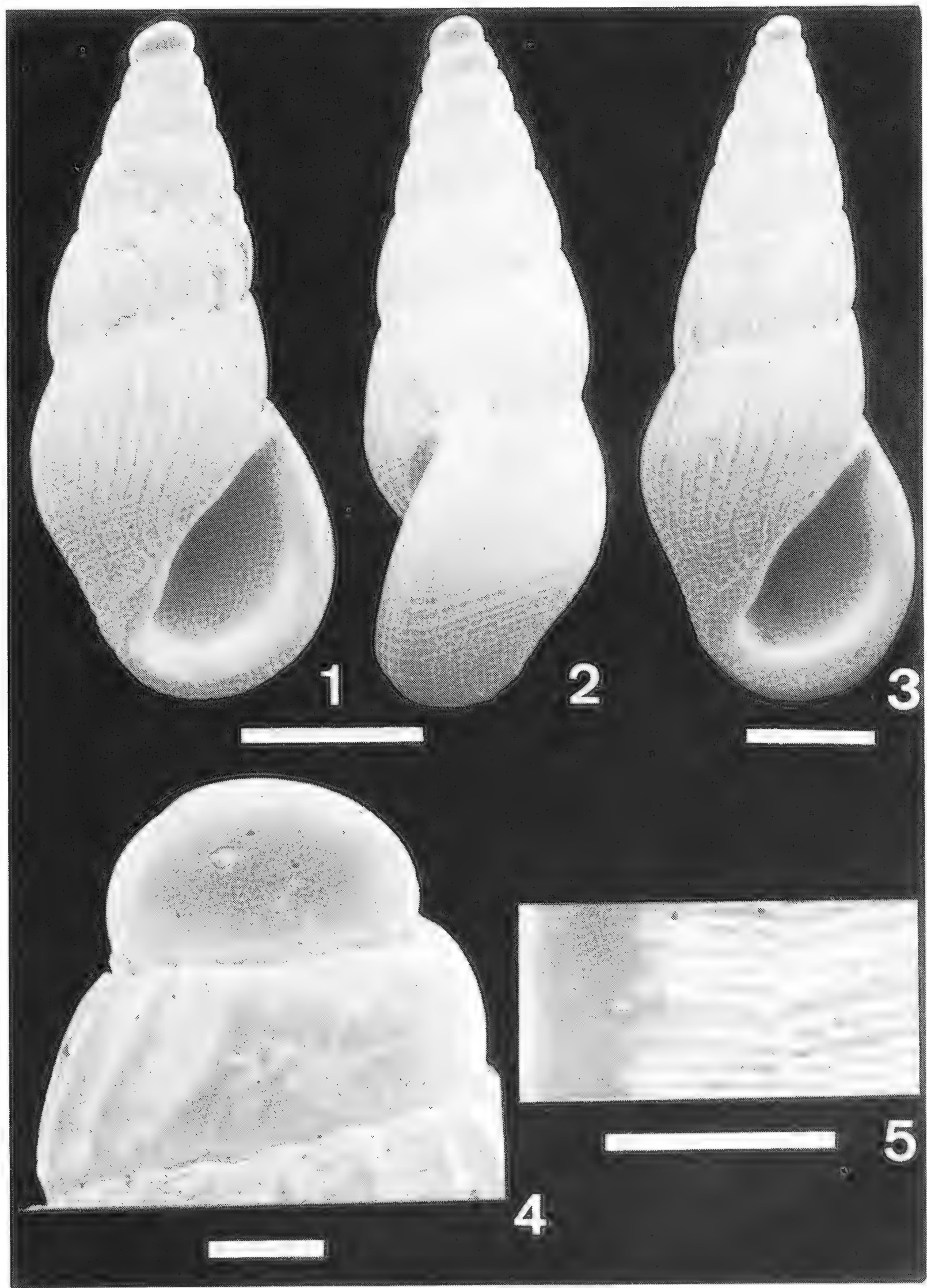


Plate 2

Figs. 1–5: *Rissoina (Rissoina) schubelae* n.sp., Oeno Atoll 1, 5: Apertural view (Fig. 1) and microsculpture (Fig. 5) of holotype (UMZC, 120742). 2. Lateral view of paratype no 9 (KBIN IG. 28.034). 3. Apertural view of paratype no 1 (KBIN). 4. Protoconch (KBIN).  
Scale bars: Figs. 1–3: 1 mm; Fig. 4: 100  $\mu$ m; Fig. 5: 50  $\mu$ m.

coll. R.C. Preece, Nov. 1991 (Paratype no 1 and no 2 in KBIN, IG. 28.034; 10 paratypes in BPBM (BPBM 248738); other paratypes in UMZC, 120742.A-O).

*Additional material examined:* Oeno Atoll, Nov. 1991, coll. R. C. Preece, 191 specimens (UMZC).

*Affinities and differences:* *Rissoina* (s.s.) *schubelae* is very similar to *Rissoina modesta* Gould, 1861 described from Okinawa, but differs in lacking the spiral threads on the spire whorls and on the adapical half of the last whorl; furthermore, the protoconch is more depressed. *Rissoina schubelae* differs from *R. tenuistriata* Pease, 1867 in having a protoconch of non-planktotrophic larval development; the spiral sculpture can be more prominent on the last whorl in specimens of *R. tenuistriata* and the spire whorls are slightly more convex. Both species show a similar degree of variation in shell length and in some specimens having a strongly distorted spire whorl with respect to the last whorl.

*Etymology:* This species is named after Susan Schubel, a member of the Sir Peter Scott Commemorative Expedition, who helped collect much of this material.

***Rissoina (Apataxia) cerithiiformis* Tryon, 1887**

*Rissoina cerithiiformis* Tryon, 1887: p. 384, pl. 57, fig. 92.

*Rissoina miltozona* Tomlin, 1915, p. 321; Kay 1979, p. 84, figs. 26 B & 29D.

*Rissoina (Apataxia) cerithiiformis* Tryon: Sleurs 1993 p. 105, figs. 32 A-C; 33 A-C; 34 A-D; 35 A-E; 36 A-B; 52 D; 54 C.

TABLE 2

*Rissoina (Rissoina) schubelae*. Shell dimensions and rib counts. (L: shell length; Ls: spire length; D: diameter of last whorl; D<sub>n-1</sub>: diameter of penultimate whorl; Dpr: diameter of protoconch; no. ax: number of axial ribs on last whorl; no. axp: number of axial ribs on penultimate whorl; no. whorls: number of teleoconch whorls).

L (mm)	Ls (mm)	D <sub>n-1</sub> (mm)	D (mm)	Dpr. (mm)	no. ax	no. axp	no. whorls
<b>Oeno Atoll:</b>							
Holotype, UMZC (Pl. 2, Figs. 1, 5)							
3.8	2.1	1.6	1.2	0.43	33	*	5
Paratypes (all in UMZC except where explicitly stated)							
(KBIN IG. 28.034): Pl. 2, Fig. 3							
5.4	3.2	2.2	1.4	0.42	34	*	6
5.4	3.2	2.2	1.6	0.40	30	27	6 $\frac{1}{4}$
4.8	2.8	1.9	1.4	0.38	32	26	6
4.4	2.6	1.8	1.3	0.40	30	33	6
4.2	2.5	1.7	1.2	0.40	44	39	5 $\frac{3}{4}$
4.1	2.4	1.7	1.3	0.41	40	36	5 $\frac{1}{2}$
4.1	2.3	1.7	1.2	0.39	29	28	5 $\frac{1}{2}$
3.8	2.2	1.6	1.2	0.39	45	44	5 $\frac{1}{2}$
(KBIN, IG. 28.034): Pl. 2, Fig. 2							
3.8	2.2	1.6	1.1	0.40	*	38	5
3.7	2.1	1.6	1.1	0.40	36	*	5
3.5	2.0	1.6	1.1	0.40	43	42	5
3.4	1.9	1.6	1.1	0.41	*	40	4 $\frac{3}{4}$
3.4	1.8	1.6	1.1	0.39	36	35	4 $\frac{3}{4}$
3.2	1.8	1.4	1.0	0.42	42	33	4 $\frac{1}{2}$
3.1	1.7	1.5	1.0	0.40	46	38	4 $\frac{1}{2}$

\*Not counted or irregularly spaced

THE RISSOININAE OF THE PITCAIRN ISLANDS, WITH DESCRIPTION OF TWO NEW SPECIES

*Material examined*: Ducie Atoll, Oct. 1991, (3 specimens); Oeno Atoll, Nov. 1991, (>50 specimens); Henderson Island, East Beach, (>50 specimens), North Beach, (17 specimens), North-West Beach (>50 specimens); all coll. R. C. Preece, Oct-Dec. 1991 (UMZC).

*Geographical distribution*: Tropical Indo-West Pacific, from the E. African coast to the Hawaiian Islands and Pitcairn Group.

***Zebina (Zebina) bidentata*** (Philippi, 1845) *sensu lato*  
(Pl. 4, Fig. 1)

*Rissoa bidentata* Philippi, 1845; p. 64.

*Rissoina eulimoides* A. Adams, 1851; p. 279.

*Rissoina coronata* Schwartz, 1860; p. 177, fig. 77.

*Rissoina semiplicata* Pease, 1867; p. 295, pl. 24, fig. 29.

*Eulima dentiens* Dunker, 1871; p. 152.

*Rissoina sublaevigata* Nevill, 1881; p. 164.

*Zebina cooperi* Oliver, 1914; p. 520, fig. 11.

*Zebina heronensis* Laseron, 1956; p. 429, fig. 117.

*Material examined*: Ducie Atoll, Oct. 1991, (12 specimens); Oeno Atoll, Nov. 1991 (>200 specimens); Henderson Island, East Beach, (109 specimens), North Beach (7 specimens), North-West Beach (>50 specimens); Pitcairn Island (55 specimens); all coll. R. C. Preece, Oct-Dec. 1991 (UMZC).

*Geographical distribution*: Tropical Indo-West Pacific from Mozambique to the Kermadec, Pitcairn, and Hawaiian Islands.

*Remarks*: *Zebina (Zebina) bidentata* (Philippi, 1845) *s.l.* is hard to define on the basis of shell characters only. Very likely, several different species are involved, which show considerable overlap in shell characters. Specimens from Henderson Island are identical in shell characters to specimens from the Tuamotu Islands and the Society Islands (pers. obs.).

This species (-complex) differs from *Z. (Z.) tridentata* Michaud, 1836 in having a less globose last whorl, in lacking the moderately prominent contraction at the shell base and in the inner lip being rather continuous posteriorly, instead of ending more abruptly as in *Z. (Z.) tridentata*.

***Zebina (Zebina) sp.***  
(Pl. 3 Figs. 2-3)

*Description*: Shell (Pl. 3, Fig. 2): strongly elongately-conical.

Protoconch (Pl. 2, Fig. 3): worn in both specimens available, but obviously of planktotrophic larval type; moderately elongate.

Teleoconch: spire whorls very weakly convex; last whorl moderately convex, moderately contracted near base; sutures rectilinear, very weakly impressed.

Spire whorls and last whorl smooth.

Aperture: D-shaped; inner lip very thin and narrow, not expanded anteriorly; outer lip moderately thickened internally, with weak swelling posteriorly, near transition to narrow and deep posterior channel; anterior channel almost absent; outer lip externally with moderately opisthocline, rather wide and thick varix.

Operculum, radula and internal anatomy: unknown.

Shell dimensions: see table 3.



*Material examined:* Henderson Island, East Beach, Oct-Dec. 1991, coll. R. C. Preece, 2 specimens (UMZC).

*Affinities and differences:* *Zebina* (*Zebina*) sp. is superficially similar to *Zebina* (*Zebina*) *linearis*

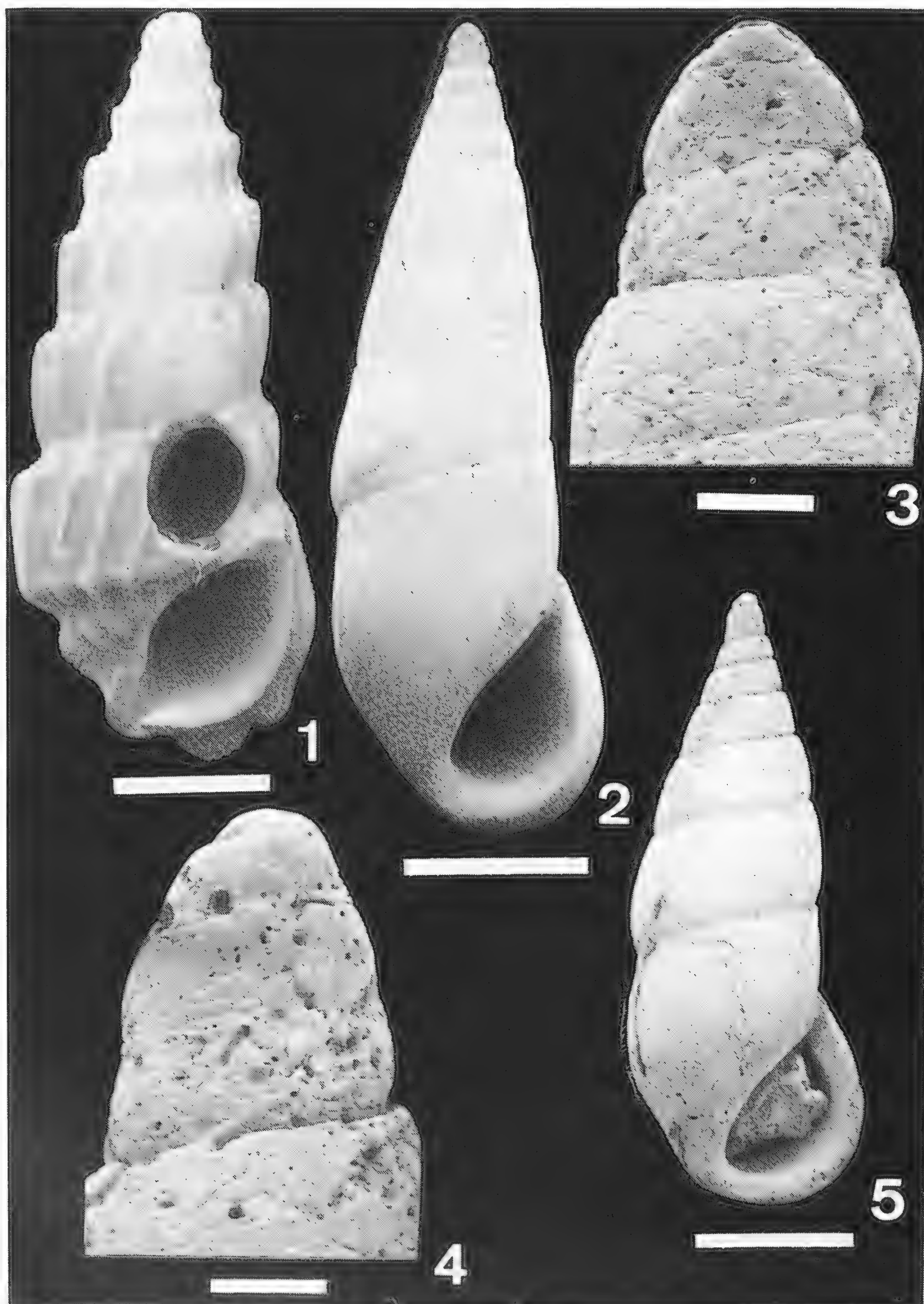


Plate 3

Fig. 1: *Rissoina* (*Rissoina*) *heronensis* (Laseron, 1956), Henderson Island, apertural view of shell (UMZC).

Figs. 2–3: *Zebina* (*Zebina*) sp., East Beach, Henderson Island, apertural view of shell (Fig. 2) and protoconch (Fig. 3) (UMZC).

Figs. 4–5: *Zebina* (? *Zebina*) sp., East Beach, Henderson Island, protoconch (Fig. 4) and apertural view (Fig. 5) of shell (UMZC).

Scale bars: Figs 1–2, 5: 1 mm; Figs. 3–4: 100  $\mu$ m.

TABLE 3

*Zebina (Zebina)* sp. Shell dimensions (L: shell length; Ls: spire length; D: diameter of last whorl; no. whorls: number of teleoconch whorls).

	L (mm)	Ls (mm)	D (mm)	no. whorls
Henderson Island				
KBIN (Pl. 3, Figs. 2–3)	4.3	2.8	1.4	7½
(UMZC)	4.2	2.7	1.4	7

Laseron, 1956 from Christmas Island (S. of Java) in being strongly elongate, but differs in having a less conical protoconch; furthermore, *Z. linearis* lacks the swelling on the inner side of the outer lip of the aperture and the inner lip is slightly expanded anteriorly over the shell base.

*Remarks:* Notwithstanding that *Zebina (Zebina)* sp. is probably an undescribed species, we hesitate to name it here until specimens with a well preserved protoconch are available for examination.

***Zebina (? Zebina)*** sp.  
(Pl. 3, Figs. 4–5)

*Material examined:* Henderson Island, East Beach, Oct-Dec. 1991, coll. R. C. Preece, 3 specimens (UMZC).

*Geographical distribution:* Tropical Indo-West Pacific from the E. African coast to the Pitcairn Islands.

*Remarks:* Both specimens from Henderson Island belong to an undescribed and unnamed species, which will be described at length by one of us (W.S.) elsewhere.

***Stosicia chiltoni*** (Oliver, 1914) *sensu lato*  
(Pl. 4, Figs. 2–3)

*Isselia chiltoni* Oliver, 1914; p. 520, fig. 12.  
*Isseliella chiltoni* (Oliver): Rehder 1980; p. 138, pl. 5, fig. 2.

*Material examined:* Ducie Atoll, Oct. 1991 (1 specimen); Oeno Atoll, Nov. 1991, (51 specimens); Pitcairn Island (33 very worn specimens tentatively attributed to this species); Henderson Island, East Beach, (74 specimens) North-West Beach (20 specimens); all coll. R. C. Preece, Oct-Dec. 1991 (UMZC).

*Geographical distribution:* Raoul Island (Kermadec Islands), Pitcairn Islands and Easter Island.

TABLE 4

*Zebina (? Zebina)* sp. Shell dimensions (L: shell length; Ls: spire length; D: diameter of last whorl; no. whorls: number of teleoconch whorls).

	L (mm)	Ls (mm)	D (mm)	no. whorls
(Pl. 3, Figs. 4–5)	3.9	2.5	1.5	ca.7 (apex worn)
	3.3	2.1	1.4	5½
		77		

*Remarks:* This species is conspecific with Kermadec material (pers. obs.) and with specimens from Easter Island and it shows the same degree of variation in shell shape and sculpture in all three localities.

*Stosicia* sp. cf. *hiloense* (Pilsbry & Vanatta, 1908)  
(Pl. 4, Figs. 4–6)

? *Bittium hiloense* Pilsbry & Vanatta, 1908: p. 56, fig. 1.

*Material examined:* Oeno Atoll, Nov. 1991 (8 specimens); Henderson Island, North-West Beach (2 specimens), East Beach (2 specimens); all coll. R. C. Preece, Oct-Dec. 1991 (UMZC).

*Description:* Shell (Pl. 4, Fig. 4): medium-sized (up to 4.7 mm,  $n = 9$ ), elongate, conical.

Protoconch (Pl. 4, Fig. 5): of non-planktotrophic larval type, of  $1\frac{1}{4}$  smooth whorls; transition to teleoconch abrupt with non-thickened, very slightly sinuous margin.

Teleoconch: spire whorls almost flat-sided; last whorl weakly convex, very slightly contracted near base.

Three to four adapical spire whorls angulated below and above very weakly impressed sutures.

Axial sculpture of weakly prosocline to slightly opisthocline ribs, the latter narrow and widely spaced on adapical spire whorls, but gradually weaker and wider on abapical spire whorls and last whorl; axial ribs absent on abapical half of last whorl.

Two very widely spaced and narrow spiral ribs on first whorl, forming prominent nodules where intersecting axial ribs; spiral ribs gradually more prominent, more numerous and wider on subsequent whorls (4 and 5 on penultimate whorl), forming weak nodules where intersecting axial ribs; interspaces between spiral ribs rather narrow on abapical spire whorls, but wider on last whorl; spiral ribs on abapical half of last whorl very narrow, sharp, rather weak and rather distantly spaced.

Microsculpture (Pl. 4, Fig. 6) of weak axial threads between axial ribs.

Aperture: lenticular; outer lip broken in most specimens or with repaired outer lip; inner

TABLE 5

*Stosicia* sp. cf. *hiloense*. Shell dimensions and rib counts. (L: shell length; Ls: spire length; D: diameter of last whorl;  $D_{n-1}$ : diameter of penultimate whorl; Dpr: diameter of protoconch; no. ax: number of axial ribs on last whorl; no. axp: number of axial ribs on penultimate whorl; no. sp: number of spiral ribs on penultimate whorl; no. whorls: number of teleoconch whorls).

L (mm) whorls	Ls (mm)	$D_{n-1}$ (mm)	D (mm)	Dpr. (mm)	no. ax	no. axp	no. sp	no.
<b>Oeno Atoll:</b>								
KBIN (Pl. 4, Fig. 5)								
4.9	3.1	2.0	1.7	0.35	10	16	5	6
UMZC								
4.7	2.9	1.9	1.6	0.33	9	19	4	6
4.6	2.7	1.9	1.6	0.33	12	19	4	6
4.4	2.7	1.8	1.5	0.36	11	16	4	$5\frac{1}{2}$
4.3	2.7	1.8	1.5	0.35	9	15	4	$5\frac{1}{2}$
4.3	2.7	1.7	1.5	0.37	12	13	3	6
4.1	2.6	1.8	1.5	0.36	11	18	4	$5\frac{1}{2}$
4.1	2.6	1.7	1.4	0.33	11	15	4	$5\frac{3}{4}$
<b>Henderson Island</b>								
UMZC (Pl. 4, Fig. 4)								
3.8	2.3	1.6	1.3	0.34	10	14	3	$5\frac{1}{2}$



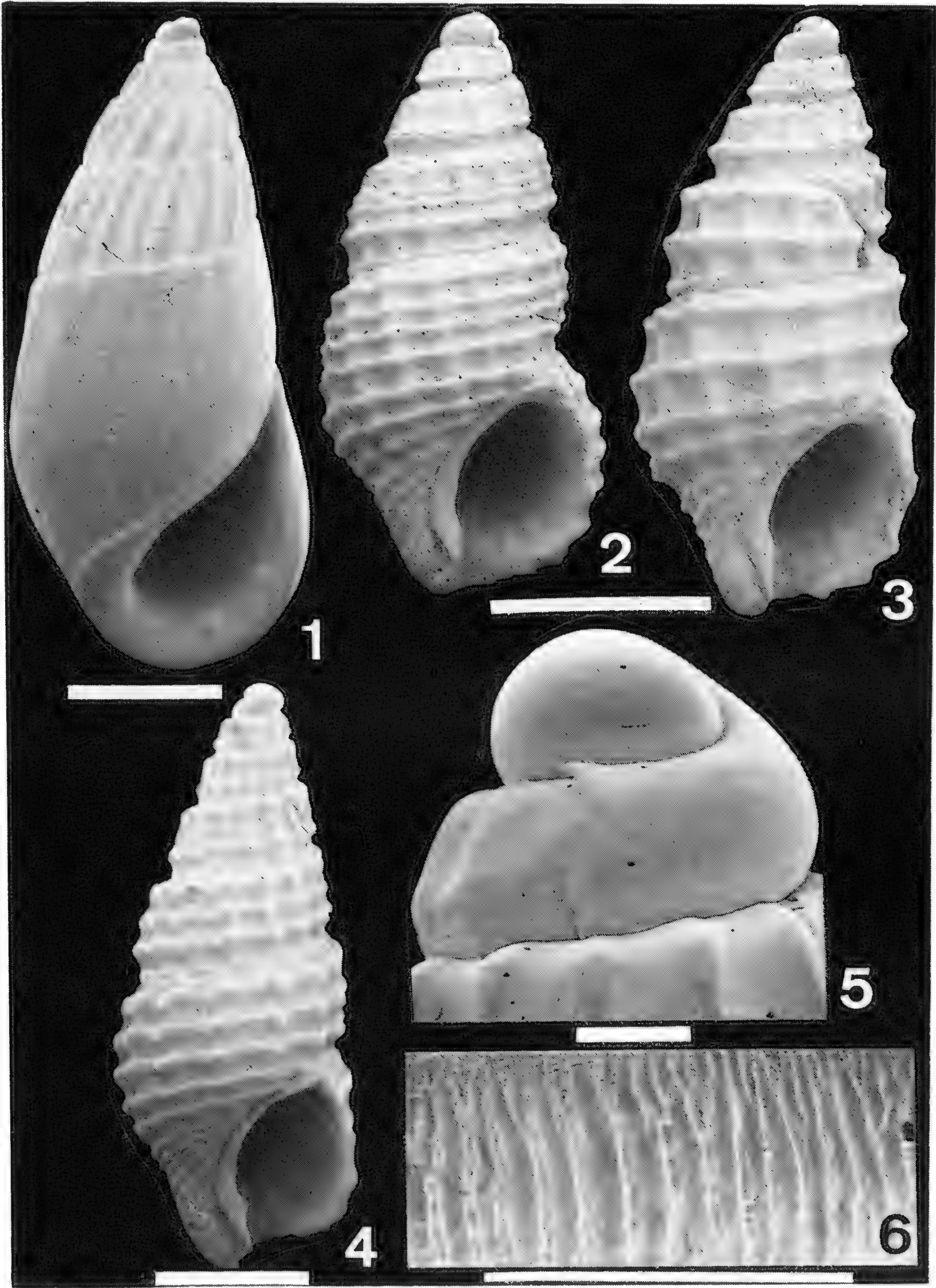


Plate 4

Fig. 1: *Zebina (Zebina) bidentata* (Philippi, 1845) *s.l.*, East Beach, Henderson Island, apertural view of shell (UMZC).  
Figs. 2–3: *Stosicia chiltoni* (Oliver, 1914) *s.l.*, East Beach, Henderson Island, apertural view of shell (UMZC).  
Figs. 4–6: *Stosicia* sp. cf. *hiloense* (Pilsbry & Vanatta, 1908); Fig. 4: 12 m, East Beach, Henderson Island, apertural view of shell (UMZC); Fig. 5: Oeno Atoll, protoconch, showing transition of teleoconch (KBIN); Fig. 6: Oeno Atoll, microsculpture (UMZC).  
Scale bars: Figs. 1–4: 1 mm; Figs 5–6: 100  $\mu$ m.

lip thin, rather narrow; transition to anterior channel with a moderately prominent swelling; anterior channel very narrow, short and deep; inner side of outer lip with moderately prominent lirae; outer lip externally with weakly prosocline, very wide, rather weak varix.  
Shell colour: white.

Operculum, radula and animal: unknown.

Shell dimensions and rib counts: see table 5.

*Affinities and differences:* The present species is similar to *Stosicia hiloense* (Pilsbry & Vanatta, 1908) but differs from the typical Hawaiian material in being more conical and less elongate, in having less prominent axial ribs, especially on the abapical spire whorls and last whorl, and in having more prominent axial threads in the interspaces between the spiral ribs. Furthermore, specimens of *S. hiloense* from Hawaii are less variable with respect to the shell features than the Pitcairn specimens.

The Pitcairn specimens are very similar to an undescribed Indo-Pacific *Stosicia* species in teleoconch and apertural characters, but differ essentially in having a non-planktotrophic larval development. It is therefore possible that the Pitcairn species is endemic, perhaps derived from a widespread Indo-Pacific species with planktotrophic development.

## DISCUSSION

The only information about the Rissoininae from the Pitcairn Islands is the material recorded in this paper. Twelve species belonging to this subfamily are here recorded from the Pitcairn Group. *Rissoina* (*s.s.*) *ambigua*, *R. (R.) heronensis*, *R. (R.) tenuistriata*, *R. (Apataxia) cerithiiformis* and *Zebina* (? *s.s.*) sp. have wide Indo-Pacific distributions, and they are all characterized by planktotrophic larval development.

On the other hand, *Rissoina* (*Rissoina*) *costata* Adams, 1851, a species with non-planktotrophic larval development, seems to be endemic to the Central Pacific. *Rissoina* (*R.*) *fratercula* sp. nov. is very similar to *R. costata* but is distinctly smaller. It too exhibits non-planktotrophic larval development and is currently known only from the Pitcairn Islands. It is interesting to note that *R. fratercula* was also present in the fossil fauna from the uplifted reef on the plateau of Henderson Island demonstrating a long history on this island.

*Rissoina* (*s.s.*) *schubelae* sp. nov., a second species described here for the first time, is most similar to *R. tenuistriata* Pease, 1867, but differs essentially in having a non-planktotrophic protoconch. It is noticeable that both species show the same variation with respect to the shell form, i.e. the whorls of the spire which can be strongly deflected with respect to the last whorl. Since this shell form is rather uncommon in the Rissoininae, we suggest that *R. schubelae* and *R. tenuistriata* share a common ancestor.

*Zebina* (*Zebina*) *bidentata* (Philippi, 1845) *s.l.* very probably represents a species-complex, but specimens from different localities are hardly distinguishable on the basis of shell characters alone. Although there is a great deal of morphological overlap between specimens from several localities, those from the Pitcairn Islands are morphologically indistinguishable from specimens from the Tuamotu and Society Islands. This species has a non-planktotrophic larval development. Like *R. fratercula*, fossil specimens of *Z. bidentata* were also recovered from the uplifted reef on Henderson Island.

One *Zebina* (*s.s.*) species with a planktotrophic protoconch appears to be unnamed, but since only two rather worn specimens were available to us, we hesitate to describe it formally here. As it is characterized by a planktotrophic protoconch we do not expect it to be endemic to the Pitcairn Islands.

The genus *Stosicia* is represented by two species. *Stosicia chiltoni* (Oliver, 1914) is very variable with respect to shell features. It was described from the Kermadec Islands (Oliver, 1914) and reported from Easter Island (Rehder, 1980). The second *Stosicia* species superficially resembles *Stosicia hiloense* (Pilsbry & Vanatta, 1908) from Hawaii, but more closely matches an undescribed Indo-Pacific species with a planktotrophic protoconch.



Therefore it is possible that the non-planktotrophic Pitcairn species is endemic, having been derived from a form, widespread in the Indo-Pacific, with planktotrophic development. The study of the internal anatomy, especially the penial characters, may give us a better insight into the relationship of this species.

The new taxa described here from the Pitcairn Islands add to the growing number of species that appear to be endemic to southeastern Polynesia. Indeed, Kay (1984) showed that within the Pacific today, this is one of two centres of endemism, the other being the Hawaiian Islands. The traditional explanation for speciation in such remote areas invokes limited larval dispersal which, given time, causes reduced gene flow and results in subsequent differentiation into new taxa. It is significant that some of the islands in Hawaii and those of southeastern Polynesia are among the oldest of the Pacific Plate. The loss of a planktotrophic larval stage, as suggested above for some of the species of Rissoininae, is likely to be a key factor in the formation of new taxa. This simple model not only accounts for the existence of island endemics but also explains the occurrence of species that are widespread on the Pacific Plate (cf. Kay 1984).

#### ACKNOWLEDGEMENTS

RCP would like to thank all the other members of the Expedition for their help and encouragement. Particular thanks are extended to Michael Brooke for his initial invitation to join the venture and to the Leverhulme Trust and Percy Sladen Memorial Fund for their financial support. Ian Killeen helped sort some of the sediment samples. We are also grateful to Gustav Paulay and Winston Ponder for their help and for reading an earlier draft.

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## OBITUARY

### PHILIP G. CAMBRIDGE

Philip Cambridge died of a heart attack in his sleep on 29th May 1993, leaving his wife Mildred (Mil), his daughter Rilla and a granddaughter. Born on 2nd June 1918 he had nearly reached his 75th birthday. Phil was widely known as an enthusiastic collector and dedicated conchologist, palaeontologist and geologist with a particular, but far from exclusive, commitment to the East Anglian Craggs and their equivalents in Belgium and the Netherlands. An avid correspondent he kept in touch with amateurs and professionals in his fields of interest both in the United Kingdom and abroad and had particularly close links with the Netherlands.

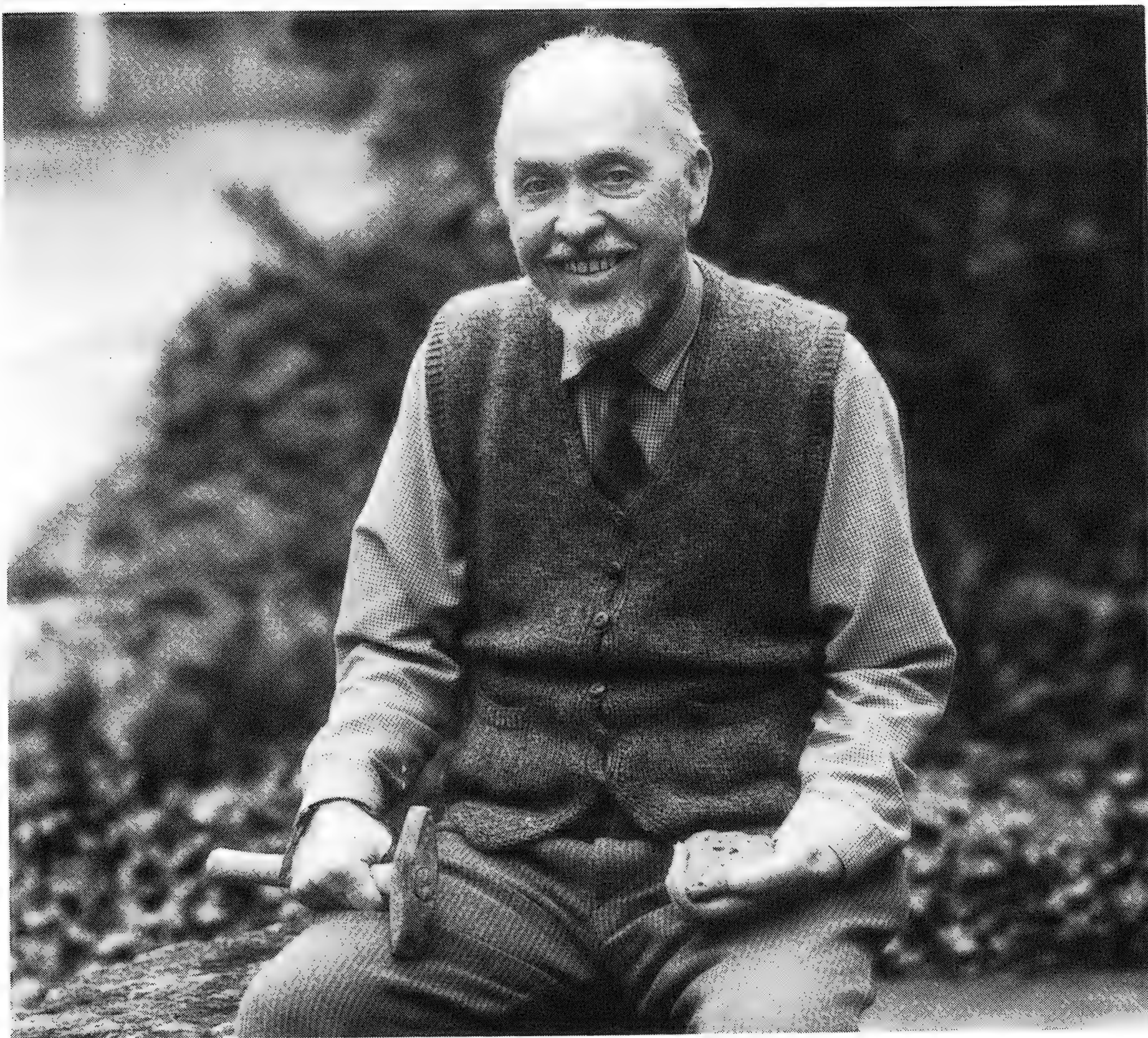
From beginnings as a boyhood fossil collector from the Lias of the South Wales coast and from walls on his way to school Philip acquired both an impressive, well documented collection and a vast store of knowledge of all sorts of fossils, recent shells, geology and geologists, to mention only his main scientific interests. In addition he was an expert on old English, Indian and other foreign coins, a skilled camera user who at one time judged local photographic competitions, and had discovered unusual archaeological finds while serving in Aden. He was gifted with an extraordinary degree of curiosity and a sharp eye for the rare or unusual.

Although Phil was born in Cheddar he spent most of his boyhood in Cardiff. Leaving elementary school before he was sixteen he landed an improbable job as a window dresser in a womens' clothes shop after some other short-lived positions. The experience swiftly sent him back to one of his masters who, coupled with mathematical tuition from a neighbour, helped and encouraged him to enter the RAF as an apprentice, the first elementary school pupil from Wales to succeed in the entrance examination. He served in the RAF as a fitter-armourer, maintaining nuclear missiles at secret sites in East Anglia as a grand finale to activities which ranged from volunteering as an air gunner in the Battle of Britain to running a forces' radio programme in Aden. The inevitable periods of inactivity while on duty enabled him to read widely, pursue his very active correspondence, to catalogue his collection and to produce a unique card index of descriptions and figures of Crag fossils.

His service career inevitably led to frequent moves and the arrangement of much of his collection in order of size rather than taxon or location reflected the need to keep it easily transportable. An early wartime spell in Medicine Hat, Canada rekindled his enthusiasm for geology and palaeontology, which, he used to explain, had been set aside for the normal youthful reasons. He met a keen geological guide in the Rev. Butcher and this return to geology was also marked by the use of a dinosaur vertebra as a doorstop and an ill-judged kick at a riverside log which painfully proved to be petrified. Later in the second world war he was stationed in Gloucestershire where a combination of military excavations, bomb craters and traditional pits allowed exciting collection from the Lias. In retirement Phillip still recalled the ichthyosaur that he and Mil were unable to carry from a Cheltenham quarry.

About 1946 he was posted to RAF Wattisham in Suffolk and became acquainted with and fascinated by the shell-rich Coralline, Red and Norwich Craggs collecting keenly from many temporary exposures, for example at Felixstowe. The Craggs and their European equivalents remained the main focus of his collecting and geological interests for the rest of his life. This meant that his post-RAF career as chief technician and latterly research assistant in the School of Environmental Sciences, University of East Anglia was singularly





Philip Cambridge.

appropriate. He made this transition after 33 years in the RAF and stayed in his university role for a further 15 years.

Philip's conchological interests encompassed all aspects of the Pliocene and Pleistocene marine faunas of the North Sea basin. He was particularly curious about *Nucella*, its origins and variations both in the late Pliocene and recently. He published a biometric paper on recent *N. lapillus* with Dr Kitching but sadly a taxonomic treatment of fossil forms with a Dutch friend as co-author did not reach the press. Settling in Norwich gave him ample opportunity to excavate the classic Norwich Crag sites at Bramerton and it was from the lower part of Blakes pit with its temperate pollen assemblage that he recovered the juvenile stages of a Mediterranean slug *Parmacella*, a very indicative pointer to the mildness of the Early Pleistocene climate at that stage. Less substantially he contributed to the *Conchologists' Newsletter* at intervals between 1963 and 1992 and wrote No 6 in the Papers for Students series on *Post-Pliocene Fossil Mollusca (Land and Freshwater)*. As the long serving editor he produced almost all the Geological Society of Norfolk's newsletters.

It would be unfair to judge Philip's contributions to conchology and geology solely on his publication list as it is mainly in local journals, often in the form of reports on field meetings which he led. Many publications on the East Anglian Crags since 1970, ranging from early attempts at amino-stratigraphy using crag shells, to studies on extinct voles, acknowledge his contributions of specimens, discussion or services such as sedimentological analysis.



## OBITUARY

Investigators on various aspects of the crags or molluscs generally, including some from the United States and Italy, sought him out in his last decade on questions including taxonomy of *Neptunea*, late Pliocene bivalve extinctions in the North Sea, molluscan migrations from the north-eastern Pacific and the early history of North Sea *Littorina*. His own inquisitiveness covered everything from trace fossils to mammal remains and on to exotic crag pebbles such as *Rhacomitra* chert. The personalities of earlier investigators were included, he had an intriguing folder on F. W. Harmer, the long lived monographer of British Pliocene gastropods, clothing manufacturer and Lord Mayor of Norwich.

To some of us he is particularly memorable for his enthusiasm for JCB's, stemming from his successful use of one to excavate an old Norwich Crag pit at Bulcamp (Suffolk) in 1979. Subsequently he was able to get Geologists' Association and other sponsorship for excavations mainly into Coralline Crag at Ramsholt (1974), Sutton (1989 and 1993) and Gedgrave Broome Pit (1992) while dreaming of locating the gastropod rich Gomer Pit (under trees) or the puzzling Boytonian now in a RSPB reserve.

Philip participated very actively in the affairs of societies relevant to his interests, particularly leading many field meetings in East Anglia and one to the Pliocene exposures around Antwerp in 1973. He was a member of the Conchological Society since 1961 and the Geologists' Association from 1943, serving on the latter's council for two years and receiving their Foulerton Award in 1970. He was especially linked to the Geological Society of Norfolk as a founder member, long serving treasurer, editor of the newsletter and assistant editor of their Bulletin. Geological societies from other parts of the country regularly obtained his services as leader for their crag excursions and he was a contributor to the 1988 Quaternary Research Association's field meeting to the Pliocene and Lower to Middle Pleistocene of East Anglia.

Philip seemed to be blessed with good fortune in all his endeavours. He was active at a time when many fossiliferous exposures were available in his favourite formations and when old collections and their cabinets were readily bought and old monographs could be reasonably acquired. Later he somehow came across bargains in plastic stacking trays and other aids to collecting. He readily made and retained friends and could be expertly persuasive to landowners whose fields he wished to excavate. At one time he rode a motor assisted bicycle along Suffolk lanes and around the shelly Wexford gravels of Ireland but he never drove a car, relying on friends for transport, particularly Colin Dack from his RAF days.

Philip's ashes were privately scattered near the Coralline and Red Crag pits at Sutton, near Woodbridge, on 20th June 1993 and a gathering of friends followed. He was especially fond of this spot which had provided so many points of interest to the early Crag investigators and had produced so many of the molluscs figured by Searles Wood. When he died he was in the last stages of planning excavations there, supported by the Geologists' Association's Curry Fund, to extend those, similarly sponsored, which had been so successful in 1989. His collection of fossils is now in the Sedgwick Museum, Cambridge, whereas his collection of recent shells is in the National Museum of Wales, Cardiff.

P. E. LONG

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## COMMUNICATIONS

### INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The following Applications were published on 30 September 1993 in Vol. 50, Part 3 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

#### Case 2871

***Helix nitidula* Draparnaud, 1805 and *H. nitens* Michaud, 1831**

**(currently *Aegopinella nitidula* and *A. nitens*; Mollusca, Gastropoda): proposed conservation of the specific names and designation of a neotype for *H. nitidula***

Edmund Gittenberger

*Nationaal Natuurhistorisch Museum, P. O. Box 9517, NL 2300 RA, Leiden, The Netherlands*

**Abstract.** The purpose of this application is to conserve the specific names of *Aegopinella nitidula* (Draparnaud, 1805) and *A. nitens* (Michaud, 1831) which are in universal use for common terrestrial pulmonate species (family ZONITIDAE) from western Europe. It has long been recognised that the existing syntype of *A. nitidula* is a specimen of *A. nitens* and it is therefore proposed that a neotype be designated for the former species in accordance with current usage, so conserving also the usage of *A. nitens*. The suppression is proposed of *Helix nitens* Gmelin, [1791], a little-used senior primary homonym of *H. nitens* Michaud, 1831 but a junior objective synonym of *H. nitida* Müller, 1774. The name *H. nitidula* Draparnaud was placed on the Official List in Opinion 336 (March 1955).

#### Case 2860

***Pleurotoma meneghinii* Mayer, 1868 (currently *Asthenotoma meneghinii*; Mollusca, Gastropoda): proposed replacement of neotype by rediscovered lectotype**

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**Abstract.** The purpose of this application is to replace the neotype of the Upper Miocene species *Pleurotoma meneghinii* Mayer, 1868, designated in 1990, by a lectotype selected from the type series of the taxon which has been rediscovered recently in the Mayer-Eymar collection in the Naturhistorisches Museum, Basel. The neotype and proposed lectotype are conspecific. *P. meneghinii* is the type species *Asthenotoma* Harris & Burrows, 1891, a gastropod genus (family TURRIDAE) which includes mainly species from the European Tertiary.

#### *Opinions published in the Bulletin of Zoological Nomenclature*

The following Opinion was published on 30 September 1993 in Vol. 50, Part 3 of the *Bulletin of Zoological Nomenclature*.

Opinion 1739. *Strombiformis albus* Da Costa, 1778 (currently *Melanetta (Balcis) alba*, Mollusca, Gastropoda): specific name conserved.

The following Application was published on 16 December 1993 in Vol. 50, Part 4 of the *Bulletin of Zoological Nomenclature*.

#### Case 2874

***Chtenopteryx* Appellöf, 1890 (Mollusca, Cephalopoda): proposed confirmation as the correct original spelling**



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**Abstract.** The purpose of this application is to confirm as correct the original spelling of the name *Chtenopteryx* Appellöf, 1890 for a genus of comb-fin squids. The unjustified emendation to *Ctenopteryx* was made in 1900, and this spelling has been universally used until very recently although with citation of Appellöf as author. However, it is a junior homonym of the coleopteran subgeneric name *Ctenopteryx* Flach, 1889. The most appropriate course of action is to confirm Appellöf's original spelling and to adopt the corrected spelling CHTENOPTERYGIDAE Grimpe, 1922 for the derived family-group name.

## MICROPILINA MINUTA WARÉN, 1989 A MONOPLACOPHORAN NEW TO THE BRITISH MARINE FAUNA

The Monoplacophora are the most primitive known class of extant molluscs with a fossil history extending back to the early Palaeozoic. They possess simple, limpet-like shells and have been found only in deep water (generally over 400 m). The current interest in bathyal and abyssal faunas has resulted in much more material being made available for research. At present five species are recognised from the North Atlantic (see Goud, J. & Gittenberger, E. *Basteria* **57** (1993) pp. 71–78). The most northerly recorded of these is *Micropilina minuta* Warén described from 6 fresh shells collected off southeast Iceland from a depth of 900–926 metres (*Sarsia* **74** (1989) pp. 1–28).

Samples of benthos collected by *R.R.S. Challenger* in 1976 have been made available to us for sorting by the Dunstaffnage Marine Laboratory, Oban. All of the material examined was collected from the Wyville-Thomson Ridge which lies to the southeast of the Faeroe Bank, south of the Faeroe Islands. The Wyville-Thomson Ridge traverses the area where three Marine Sea Areas (S1, S31 & S48) meet.

Specimens of Monoplacophora that compare well with Warén's (*op cit*) illustrations of *Micropilina minuta* were found in three samples:

Station 72A, 60°12'N, 08°14'W, 900m, 2 shells.

Station 72B, 60°10'N, 08°14'W, 900m, 1 live specimen and 3 shells.

Station 73, 60°10'N, 08°12'W, 900m, 4 live specimens and 4 shells.

These specimens are very small (maximum diameter <1.5 mm) and the live-collected animals are not well preserved. Previous authors have remarked that knowledge of this class is still sketchy with very little information on interspecific anatomical differences. These are apparently the first live-collected records of *M. minuta* and, in spite of the state of preservation, at least some study of the anatomy should be possible.

In addition to *Micropilina*, analysis of the samples yielded other species of molluscs not recorded in the recent Checklist (Smith, S. M. & Heppell, D. (1991) *Checklist of the British Marine Mollusca*, National Museums of Scotland Information Series No. 11). Most of these have so far been found as dead shells mainly from Stations 72A and 73 (coordinates as above):

*Osteopelta celicola* Warén, 1989

*Palazzia ausonia* (Palazzi, 1988)

*Rugulina fragilis* (G. O. Sars, 1878)

*Larsenia scalaroides* Warén, 1989

*Pseudotorellia fragilis* Warén, 1989

*Fusceulima projectilabrum* Bouchet & Warén, 1986

*Chrysallida hoisaeteri* Warén, 1991

A full report on the molluscs from this *Challenger* cruise will be published at a later date.

We are grateful to Dr John Gage and Mr Robin Harvey of the Dunstaffnage Marine Laboratory at Oban for making this material available to us.

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*VERTIGO ANGUSTIOR* JEFFREYS, 1830 LIVING IN SCOTLAND

Recent survey work in England and Wales has revealed several disjunct populations of *Vertigo angustior* from the Gower to East Anglia. Most of these have been from rich fen in saltmarsh/dune and heath transition zones (e.g. Killeen, I. J. *The Land and Freshwater Molluscs of Suffolk*. Suffolk Naturalists' Society, Ipswich (1992)). The most northerly known population is from mossy runnels on limestone pavements at Gait Barrows N.N.R. North Lancashire (Marriot, D. K. & Marriot, R. W. *J. Conch., Lond.* **31**: (1982) p. 72). There are, however, two old records from Scotland. W. Baillie (*J. Conch., Lond.* **3**: (1882) pp. 298–99) found a single shell of *V. angustior* among a batch of *Pupilla muscorum* collected in East Sutherland, probably in the vicinity of Brora. There was clearly some doubt regarding the provenance of this specimen as it is not accepted as a Census record. The recent Scottish record is derived from a molluscan survey of S.S.S.I.s in southern Scotland undertaken for the Nature Conservancy Council by Dr C. R. C. Paul in 1974. He found shells of *V. angustior* and *V. pusilla* together in hollows in the shell sand on the south-facing beach at White Port on the east side of a peninsula into the Solway near Dalbeattie, Kirkcudbrightshire (Grid Reference NX 840519). One shell of *V. angustior* looked fairly fresh but it was cautiously considered best to regard it as sub-fossil.

The White Port site was revisited on 18th May 1992. Although no specimens were observed in the field, a small sample of litter and herbage taken away for examination at home yielded five living specimens of *V. angustior*. A further visit was made on 27th July 1992 to determine the precise habitat and extent of the colony. It was established that they were living in the western half of the fixed shell-sand dune bank from its base to about three or four metres up to the slope away from shade and below the area burrowed by rabbits. The vegetation of the lower part of the zone was mainly the common moss *Rhytidiadelphus squarrosus* among rushes (*Juncus* sp.) and thyme (*Thymus praecox*). There was less moss in the upper part of the zone, which consisted of grass and herbage, kept short by grazing rabbits. Bracken increased in frequency up the slope until it became dominant above the zone. Most of the *V. angustior* were found in the moss but some came from the thyme. They did not occur on the grassy sward above the rocks to the east of the bay. The associated species were *Cochlicopa lubricella*, *Vertigo pygmaea*, *Vallonia costata*, *Vallonia excentrica*, *Vitrina pellucida* and *Cepaea nemoralis*.

Apart from its proximity to the sea, the White Port site has little similarity to any of the English or Welsh sites. However there are many features in common with maritime sites where *V. angustior* has been found living in Ireland. Typically these sites have short-grazed turf with bare patches of sand or, in the Burren, small flakes of limestone near the high water mark; areas which would be totally submerged by high spring tides, especially if there was a coincidental storm (Norris, A. & Colville, B. *J. Conch., Lond.* **28**: (1974) pp. 141–154; Paul, C. R. C., pers. comm. and Colville, B. & Coles, B. *Conch. Newsletter* **90**: (1984) pp. 192–196).

I thank Drs M. P. Kerney and C. R. C. Paul for information they kindly contributed to this Communication and I am grateful to I. J. Killeen for his help and encouragement.

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*PUPOIDES COENOPICTUS* (HUTTON, 1834) NEW TO TUNISIA.<sup>1</sup>

Seddon (1992, *J. Conch., Lond.* **34**: 149–158) provided detailed comments on the distribution of *Pupoides coenopictus* (Hutton) extending its Quaternary distribution range from southern Saharan fringes to S. Morocco and central Algeria. This note gives the first records for Tunisia and the first live-collected records of it in NW. Africa.

In October 1992, at the oasis town of Nefta in southern Tunisia (33°53'N, 7°52'E), *Pupoides coenopictus* was found to be locally abundant within the date palm plantations. The habitat is slightly different from those reported by Seddon (*op. cit.*). The specimens were found in damp areas (often the base of irrigation channels), aestivating and crawling on the undersides of decaying date palm fronds. The underlying soil was mainly silty mud overlying the sand which predominated elsewhere within the oasis. The shells were coated in mud, as reported by Benson (*in* Pilsbry 1921, *Man. Conch. ser. 2 vol. 26. Pupillidae* Acad. Nat. Sci., Philadelphia). The associated fauna was *Cochlicella acuta* (Müller), *Trochoidea* cf. *neftana* (Bourguignat), *Caracollina lenticula* (Michaud) and *Theba pisana* (Müller).

It is difficult to know whether these species are native or introduced. There are no fossil records of *Cochlicella acuta*, *Trochoidea* sp., and *Theba pisana* from the intervening regions despite the presence of fossil shells. This suggests that it is more likely that these species were introduced rather than being relict of a more continuous distribution during periods of more humid conditions.

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<sup>1</sup> Systematics and Biogeography of the land Mollusca of NW. Africa. Contribution no 9.

## REVIEW

*A Chronological Taxonomy of Conus, 1758–1840.* By Alan J. Kohn, 1993. Washington and London: Smithsonian Institution Press. x + 315 pp, with 26 black and white plates and a coloured frontispiece. Hardback. ISBN 1–56098–094–X. Price \$45.

This book begins with the statement that, with more than 500 living species, *Conus* is probably the largest genus of marine animals on earth. Since Linnaeus described the 35 species known to him in 1758, some 2500 names have been proposed for extant taxa and more than 1000 for fossils. Kohn has reviewed and evaluated the status of all nominal species, both recent and fossil, published from 1758 to 1840, and has considered each name in chronological sequence. In this way, priority is clearly shown, and earlier synonymy or homonymy revealed. Each nominal species must be either 1) valid, 2) a synonym of an earlier or contemporary species, 3) a nomen dubium, or 4) not a *Conus*. Synonymy with later published names is not given. After 1840, species were better described and illustrated, so there is less need for this strictly chronological approach to their taxonomy.

The 315 quarto pages of this book are comprised of 11 chapters, 16 pages of references to the literature cited (which provides a useful bibliography for the genus *Conus*), and an index. The main body of the work (chapters 2–9) is based on eight papers previously published by Kohn in the *Zoological Journal of the Linnean Society* from 1963 to 1988, but the chapter dealing with the nominal species described between 1831 and 1840 is entirely new. Other chapters have been rewritten to incorporate new findings or nomenclatural acts, such as designations of types and decisions of the ICZN. The 26 black and white plates at the front of the book figure the type specimens of the species included.

An introductory chapter gives a brief history of the genus *Conus* and its taxonomic treatment, with a review of previous attempts at monographic coverage from 1758 onwards, stressing the importance of chronological analysis. The second chapter, treating the species described by Linnaeus in 1758, is considerably expanded and augmented compared with Kohn's 1963 work, while those species described later by Linnaeus (originally included in the same paper) now appear in their appropriate chronological sequence. In subsequent chapters, species are treated work by work (alphabetically by author for works published in the same year; alphabetically by species within the same work). A potted biography of each author and his main works, included in the relevant chapters, provides some very readable historical background information. Each chapter ends with a table summarizing the status of nominal species treated therein.

Although this book, Kohn's magnum opus and the distillation and culmination of more than 30 years work, will be of interest mostly to specialists, it is a model of accurate and effective presentation of its subject, with commendably few typographical errors. One minor fault of this otherwise excellent work of reference is that the Index is arranged solely by specific name, so that all homonyms are confused together. Altogether 660 species-group names are included, of which 200 (169 extant and 31 Tertiary fossils) are considered to represent valid species. Of the rest, 20 names were preoccupied, 317 were synonyms, 87 were considered nomina dubia, 23 were assigned to infrasubspecific rank, and 11 were assigned to genera other than *Conus*. The author is certainly to be congratulated on his determination and perseverance in seeing this worthy project through to this excellent culmination.

DAVID HEPPELL







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# Journal of Conchology

Vol. 35, Part 1, July 1994

## Contents

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	PAGE
PAPERS	
A. GASCOIGNE —The Dispersal of Terrestrial Gastropod Species in The Gulf of Guinea .....	1
R. G. MOOLENBEEK and H. DEKKER—New Nassariids from Oman and Somalia (Neogastropoda: Prosobranchia) .....	9
P. G. OLIVER and H. C. G. CHESNEY—Taxonomy of Arabian Bivalves Part 1. Arcoidea .....	15
H. C. G. CHESNEY and P. G. OLIVER—Taxonomy of Arabian Bivalves Part 2. A New Species of <i>Semele</i> (Bivalvia: Tellinoidea) .....	33
M. A. MUÑOZ and J. D. ACUÑA—On the Taxonomic Discrimination between <i>Patella aspera</i> Röding and <i>P. caerulea</i> Linnaeus (Gastropoda: Patellidae) using Conchological Traits .....	37
M. B. SEDDON, M.-T. APARICIO and D. T. HOLYOAK—Taxonomy of Five Species of <i>Helicopsis</i> ( <i>Helicopsis</i> ) from Morocco (Gastropoda: Helicoidea)	45
W. J. M. SLEURS and R. C. PREECE—The Rissoininae (Gastropoda: Rissoi- dae) of the Pitcairn Islands, with the Description of two New Species	67
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE .....	87
I. J. KILLEEN and S. M. SMITH— <i>Micropilina minuta</i> Warén, 1989 A monoplaco- phoran new to the British marine fauna .....	88
B. COLVILLE— <i>Vertigo angustior</i> Jeffreys, 1830 living in Scotland .....	89
M. B. SEDDON and M. HOLYOAK— <i>Pupoides coenopictus</i> (Hutton, 1834) new to Tunisia .....	89
REVIEW .....	90

# Journal of Conchology

. 35, Part 2

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# SHELL COLLECTIONS IN THE MAIDSTONE MUSEUM: 1. THE COLLECTION OF JULIUS BRENCHLEY

JUNE E. CHATFIELD<sup>1</sup>

(Accepted for publication, May 21st 1994)

*Abstract:* This paper gives the history of the shell collection and biographical background of Julius Brenchley whose large 19th century collection is in the Maidstone Museum, Kent. An important part of this collection came from Pacific islands in 1865 and includes both marine and non-marine molluscs. New taxa were described in Brenchley (1873). Type specimens described by Baird from Brenchley material have been located in Maidstone and London and a list of these is appended.

*Key words:* J. L. Brenchley, Maidstone Museum, Curaçoa cruise, Baird types, Pacific.

## INTRODUCTION

Maidstone Museum is housed in an historic building, the former Chillington Manor. It was previously called the Charles Museum after its founder, Dr Thomas Charles, who inherited Chillington House in 1840. Dr Charles amassed his own collection (antiquarian objects and minerals) which was bequeathed to Maidstone Corporation on his death in 1855. The Corporation then bought part of Chillington House and opened the museum in 1858. The first Curator was Edward Pretty who was succeeded in 1865 by W. J. Lightfoot.

Under the second Curator, W. J. Lightfoot, the museum expanded and an extension was built in the early 1870s. Part of this was prompted by the large collections of ethnographic material, shells and ferns brought back by a local man, Julius Brenchley, after his cruise on the steam frigate HMS Curaçoa in the South Seas in 1865. Brenchley was a wealthy man of private means who had no immediate descendants and he was an exceptionally generous benefactor to the museum in his native town, with donations totalling over £11,000 from 1870–1873. He bought the land around the museum for the present Brenchley Gardens, funded its landscaping and additional work to the museum building. The figures of his donations were recorded in a manuscript notebook by Lightfoot which is in the museum. A gallery on the ground floor has always been called the Brenchley Room and where a bust of Julius Brenchley still stands (Fig. 1). Shells from his collection were once on display (Philp, pers. comm. and Anon. 1909). The Maidstone Museum is currently administered by Maidstone Borough Council.

## JULIUS LUCIUS BRENCHLEY (1816–1873)

Entries in Russell's *History of Maidstone* (1881), obituaries in the *Maidstone and Kentish Journal* (1873), and other manuscript sources in the museum, provide biographical data on Julius Brenchley. He was born at Kingsley House, Stone Street, Maidstone (demolished in 1855) and was the son of John Brenchley and Mary Ann Brenchley (née Coare). His father, a former

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Fig. 1. Bust of Julius Brenchley in Maidstone Museum

Mayor of the town, set an example as a benefactor, building almshouses and establishing endowments for the inhabitants. Of the family, only Julius Brenchley and his brother John lived to middle age. Julius spent his life travelling around the world and remained a bachelor. He received his education firstly at Folkestone under the Reverend Thomas Pearce, and later at the Maidstone Grammar School before going to St John's College, Cambridge where he took his BA in 1840, proceeding to MA and taking Holy Orders. He was Curate at Trinity Church, Maidstone where he established a reputation of kindness and later was Curate at Shoreham, north of Sevenoaks, Kent, but this was given up to accompany his father on a two-year tour of the Continent in 1845. His father died in Paris in 1847. Manuscript journals of this visit are in the Maidstone Museum.

This journey round Europe developed his appetite for travel and, being of substantial private means, Brenchley spent much of the next 20 years exploring the world going to the United States, Hawaiian Islands (where he met the French naturalist Jules Remy), South America, Algeria, Morocco, India, Ceylon, China, Japan, Australia, New Zealand, islands of the South Pacific, Mongolia, Russia, Poland and France. The most significant of these travels for the Maidstone Museum was the cruise of HMS *Curaçoa* among the South Sea islands in 1865, which resulted in a large collection of shells and ethnographic material that today forms a substantial part of the holdings of the museum. This journey was the subject of Brenchley's only book *Jottings during the Cruise of HMS Curaçoa among the South Sea Islands in 1865* (Brenchley



1873). He returned from Australia via Mongolia, Russia, Poland and ended with a visit to his friend and fellow traveller Monsieur Jules Remy at Chalons-sur-Marne in northern France in 1867. He was back in Maidstone when his brother died in April 1870. Here Julius Brenchley was heavily involved with his collection, part of which was soon donated to the Maidstone Museum, with the remainder following after his death. The Curator, W. J. Lightfoot, was active in encouraging him to write an account of his travels, gave him a contact in the British Museum – Dr W. Baird<sup>1</sup> – who named the shells and described some new species. Type and other material was given to the British Museum and the various batches sent were recorded both in a manuscript notebook by Lightfoot (in the Maidstone Museum) and in the accessions registers of the Natural History Museum, South Kensington. The meticulous work of curating and documenting the material, undertaken by W. J. Lightfoot, is evident and the scientific value of the collection today owes much to the firm foundations laid when the collection went to Maidstone Museum in the 1870s. Descriptions of new species of molluscs were included as an appendix to the book and illustrated with chromolithographs (Brenchley 1873). The Brenchley collection therefore contains type material in addition to some ethnographical items of shell work which are figured (cf. Fig. 2).

In addition Lightfoot undertook Brenchley's correspondence with Dr Baird (three of Dr Baird's letters are in the museum) and one exists from Sylvanus Hanley, shell collector and conchological author, requesting an exchange of shells. The data written in Indian ink on the Brenchley shells and the entries in the Maidstone Museum manuscript catalogues are in the hand of W. J. Lightfoot. Examples of the hand writing of Julius Brenchley (which is different) are in various letters and manuscript notes in Maidstone Museum, and another letter has been found in the archives of the Royal Geographical Society, of which Brenchley was a Fellow.

During the preparation of the book Brenchley's health suddenly broke "into a complication of maladies" and he was heavily dependent on Lightfoot for completion of the book and never lived to see its publication. Insights into the last year of his life, work on the shells and book, donations to the museum and the breakdown of his health are recorded in Lightfoot's personal diaries which are in the Maidstone Museum.

From Lightfoot's personal diary:

21.12.1872 *Mr Brenchley very ill indeed, thought he would have gone off.*

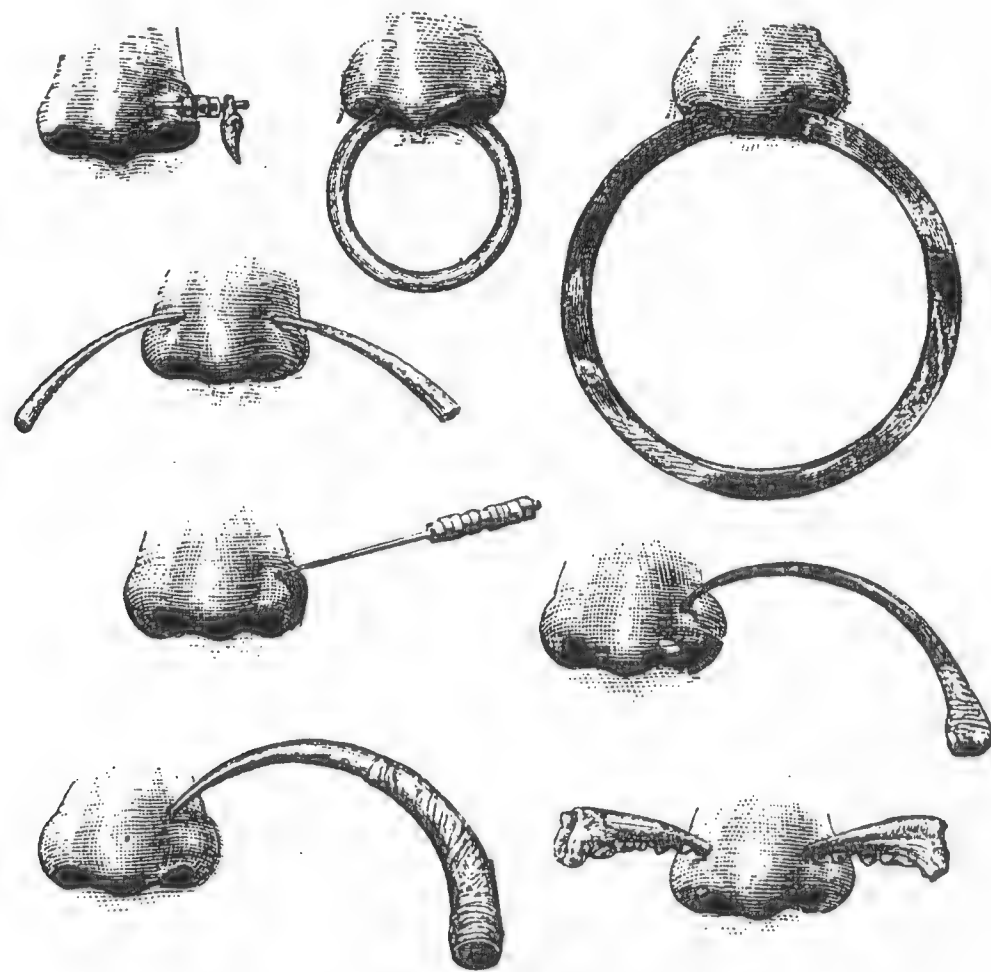


Fig. 2. Nose ornaments (from Brenchley 1873).



24.2.1873 *Elgar<sup>2</sup> and Turner began sticking the shells to the tablets. Mr Julius Brenchley MA FRGS died at Folkestone 7.30. P.M. quite tranquilly . . .*

27.2.1873 *Mr Brenchley was brought home to Milgate this evening from Folkestone accompanied by M. Remy . . .*

1.3.1873 *Mr Brenchley was buried in the afternoon in family Vault near south door of south chapel All Saints Church, Maidstone. . . . A great number of people present. Shops all shut during the funeral.*

The family memorial with inscriptions in memory of three generations of Brenchleys can still be seen outside the church.

Brenchley's death was recorded in a postscript to the Preface of his book. Brenchley went to stay in Folkestone and died there on 24 February 1873. It is likely that "the friend of Mr Brenchley" who wrote the anonymous preface was in fact Lightfoot. The three who had together worked on the shells collected during the Curaçoa cruise all died within a few years of each other in the early 1870s. Dr Baird (who identified the shells) was also reported as deceased in the Preface to Brenchley's book published in 1873 and in Lightfoot's diary entry for 27 January 1872, while William Lightfoot died shortly after. In 1875 he was replaced as Curator by Edward Bartlett.

### THE CRUISE OF THE CURAÇOA

Whilst in Sydney, Australia in 1865, Julius Brenchley met Commodore Sir William Wiseman and was invited to participate in his cruise in HMS Curaçoa around the South Pacific islands, their route being charted on a map in the subsequent book (Brenchley 1873). They travelled to Norfolk Island, Niue or Savage Island, Tutuilo and Upolu in the Samoan Group, Vavau and Tongatabu in the Tonga Group, Ovalau, Mbau, Viti-Levu and Landavu in the Fiji Group, Anatom and Tanna in the New Hebrides, Vate, Sandwich Island (Hawaii), Vanau-Lava – Bank's Island, Santa-Cruz Island, Ulakua, Uji, San Christoval, Guadalcanai, Florida and Ysabel in the Solomon Group, Eramanga in the New Hebrides and New Caledonia (Loyalty Islands). They left Sydney on 4 June 1865 and returned on 13 October 1865. Brenchley's book gives a general account of the journey and the South Sea islands, some details on the local inhabitants and their customs (including cannibalism) and occasional references to land, freshwater and marine shells and their use in artefacts. In the acknowledgement and in the text he records help in shell collecting from Mr Brazier<sup>3</sup> nicknamed "Jack Shells" by the crew and Mr Veitch<sup>4</sup>, a horticulturalist. Mr Brazier (from Australia) also published on shells in the *Proceedings of the Zoological Society of London*, including some found during the cruise of the Curaçoa (Brazier 1872). Curiously there is no evidence of contact between Brazier and Brenchley's team subsequent to the cruise. Also collecting shells was Lt H. Festing<sup>5</sup>, Midshipman of the Curaçoa, who was from Kent: his collection is in the Maidstone Museum.

Extracts relating to shells and ethnographic items using shells taken from Brenchley's book (1873) have been collected but not published here. The book on the Curaçoa provides a useful source of data on the habitats then found as well as providing dates, localities and accounts of the climate and topography. Whilst Brenchley and Brazier collected a number of shells themselves, they also record acquiring some from the natives of the island who often surrounded the ship in their canoes on arrival at the various islands wanting to barter.

### THE EXHIBITION IN SYDNEY

On return to Sydney with a very considerable collection of sizeable ethnographic items as well as many tropical shells, Commodore Sir William Wiseman of the HMS Curaçoa

organised a public exhibition of the collection at the Diocesan Book Repository, Phillip Street, Sydney, Australia in November 1865. A catalogue was published of which ten pages is devoted to shells: localities were given, but identifications were often only to generic level. They included both tropical marine shells and land shells. Copies of the catalogue are in the Maidstone Museum.

### MOLLUSCS ON THE CRUISE OF THE CURAÇOA

Various accounts of marine, land and freshwater shells occur in the general text of Brenchley's book *Jottings during the Cruise of HMS Curaçoa among the South Sea islands in 1865* (1873) and these cover the collection of specimens while an appendix includes descriptions and illustrations of new species of molluscs which were prepared by Dr Baird, but his authorship was only acknowledged in a small footnote.

The first mention of shells, before they set foot ashore, was the appearance of canoes of the native islanders who came up to the ship to barter and shells were included in their trading material. The canoes themselves were sometimes decorated with cowries, indicating that shells were part of the Pacific Island culture. Many of the showy marine species collected during the Curaçoa voyage and now in the Maidstone Museum were probably obtained by bartering in this way.

Brenchley also relates his own collecting activities, often taking an interest in land and freshwater shells, which he seemed to appreciate as much as the marine ones and he refers to them in aesthetic terms as "pretty" and "handsome". Quotations from Brenchley have been compiled but not published. Collecting anecdotes used in the book show that Brenchley was very much a "hands on" field naturalist – there are accounts of him being immersed up to his middle in water in search of aquatic shells or sinking up to his waist in soft coral sand. With a lifetime of travel he had become accustomed to danger and to roughing it in the field.

The Curaçoa book refers to the use of a trawl to obtain more marine shells, and augment the species range obtained by barter. These would have an exact locality compared with the bartered material.

What is of practical value to malacologists today following in the footsteps of Brenchley and recording from the Pacific islands are the first hand descriptions and engraved illustrations of localities and habitats. Since the exhibition catalogue listed photographs, the engravings could well have been copied from them. He refers to brooks, ravines, sheer cliffs, mountains, woodland, cultivated ground, bare ground and the presence of lime. It would be interesting to see how the habitat has changed today.

Many of the references to shells in the book concern their use by the native populations of the islands. Women were seen gathering shellfish and shells were collected for barter with visiting ships. They used shells extensively for decorative purposes – on their canoes, roofs of huts, as ear rings, nose ornaments, armlets, head ornaments, necklaces and shell craft with pieces of shells cut out into discs or made into beads. In shell craft there was often a skillful combination of colours, particularly black and white and also the use of nacre or mother-of-pearl obtained from the pearly nautilus. Large gastropod shells were sliced to make circular armlets. Brenchley compared the skill of the various island communities in their shell work and regarded those of Ulakua Island in the Solomon Group as the most skilled. The ornamental use of shells is mentioned frequently in the book and some items were figured. The same items are today in the Maidstone Museum and an exhibition on the ethnographic collection of Julius Brenchley is in preparation. The Money Cowrie *Cypraea moneta* L. was used as a currency and possibly the Gold Ring Cowrie *C. annulus* L. also.

Whilst on Fiji, Brenchley came across Madame Graaffe, one of the missionary community who had a shell collection. She made up a representative sample which

Brenchley bought from her after a difficult session of bargaining. Missionaries were much in evidence on the islands in those days. First hand impressions of the Pacific islands include reference to the climate which has an influence on the molluscan fauna. The island of Anatom in the new Hebrides was recorded as seldom below 62° F (18°), never above 94° (34°) F and seldom above 89° F (32°) in the shade. The mountainous islands were described as well watered, droughts were unknown and rain fell every month. On Christoval Island in the Solomon Group, Brenchley waded in the river, but after a couple of hours he felt rather cold – so presumably the freshwater mollusc fauna enjoyed a stable low water temperature.

Different molluscs come up for specific mention including the tusk shell *Dentalium*, pearl oyster, cowries, mitres, clams, land shells and freshwater mussels.

Some of the time at sea was taken up in caring for the collection, making notes, labelling and packing. The recording of locality data makes this collection an invaluable historical data-base for this little studied group of islands. Much of the work was undertaken in cramped quarters and the collecting must have posed a considerable storage problem on board ship. Parts of it were at risk from sea water on deck on rough weather and the fern collection was used by Brenchley's dog to sleep on.

### CONCHOLOGICAL DISCOVERIES

Julius Brenchley was a particularly keen and intrepid collector who had the means to indulge in a lifetime of foreign travels. Because of his book (Brenchley 1873), the Curaçoa cruise is the best documented and most important of his shell collecting. In the second part of the Preface to the book (probably written by Lightfoot) there is reference to his keeping notebooks during the cruise. These have not yet been discovered, but it is likely that they were given to the Maidstone Museum.

Brenchley packed up his collection in an orderly way but it was also fortunate that Lightfoot was around to assist him with the collection and to encourage and probably give substantial help in the writing of the book. The biological material, through Lightfoot, was submitted to specialists at the British Museum – Dr Baird undertaking the shells. The Appendix in Brenchley 1873 includes descriptions and illustrations of 34 new species and one new variety of molluscs, of which seven consisted of marine bivalves, one chiton and the remainder marine and non-marine gastropods. The shells going to the British Museum (carefully wrapped in paper and numbered by Lightfoot) were sent up to London by carrier in eight batches from 5 November 1870 to 25 May 1871 and these consisted of around 620 species which Lightfoot recorded in a manuscript notebook at the Maidstone Museum. Duplicate material, including type specimens, was retained by the British Museum and their accession registers of Mollusca and Radiated Animals now in the Mollusca Section of The Natural History Museum, South Kensington show the following entries for Brenchley material: 70.12.31: 1–339; 71.2.10: 1 – 188; 71.4.26: 1 – 39; 71.8.26: 5 – 27; 71.12.21: 1 – 3; 72.9.14: 1 – 8; 72.10.5: 1 – 8; 73.5.2: 1 – 53; 73.5.16: 1 – 18.

It has been possible to locate 28 of the Baird types but it is possible that the others remain unrecognised in the body of the main collection and should be located. The only specimen and type of *Helicina fulgurata* Baird was recorded as being lost by the artist (Lightfoot's catalogue and Brenchley 1873, footnote page 454).

Further type lots of these species are also in the Maidstone Museum and specimens of 15 (including one variety) have already been located in the collection, with others listed in Lightfoot's catalogue. The remainder should be looked for during the continuing curation of the collection at Maidstone. Table 1 lists the new species described by Baird from the Curaçoa cruise and type material located today at Maidstone and London. Separate and detailed work is needed to re-examine these and assess which still merit specific rank and



which have been relegated to the synonymy. This paper indicates the presence of type material of Baird's new species at Maidstone and London for use by future reseachers into Pacific island molluscs.

Brenchley was honoured with three species from the Curaçoa cruise being named after him by Baird (in Brenchley 1873) – *Fusus brenchleyi* (Fig. 3), *Melania brenchleyi* and *Helicina brenchleyi*. One species, *Phasianella wisemanni*, was named after Commodore Wiseman of the steam frigate Curaçoa.

Brenchley was also honoured, posthumously, by other species named after him – *Clathrella brenchleyi* and *Tornatina brenchleyi* (Angas 1877), *Pupina brenchleyi* named at the suggestion of Mr Brazier who had collected shells with Brenchley on the Curaçoa (Smith 1891) and *Omalotropis brenchleyi* (Sykes 1900).

### THE BRENCHLEY COLLECTION

A substantial part of the Brenchley Collection in the Maidstone Museum was originally mounted on wooden tablets and on display in the museum galleries. In his personal diary, Lightfoot records the mounting of shells on to tablets and there is a manuscript note by him recommending "India Rubber Cement" for this purpose.

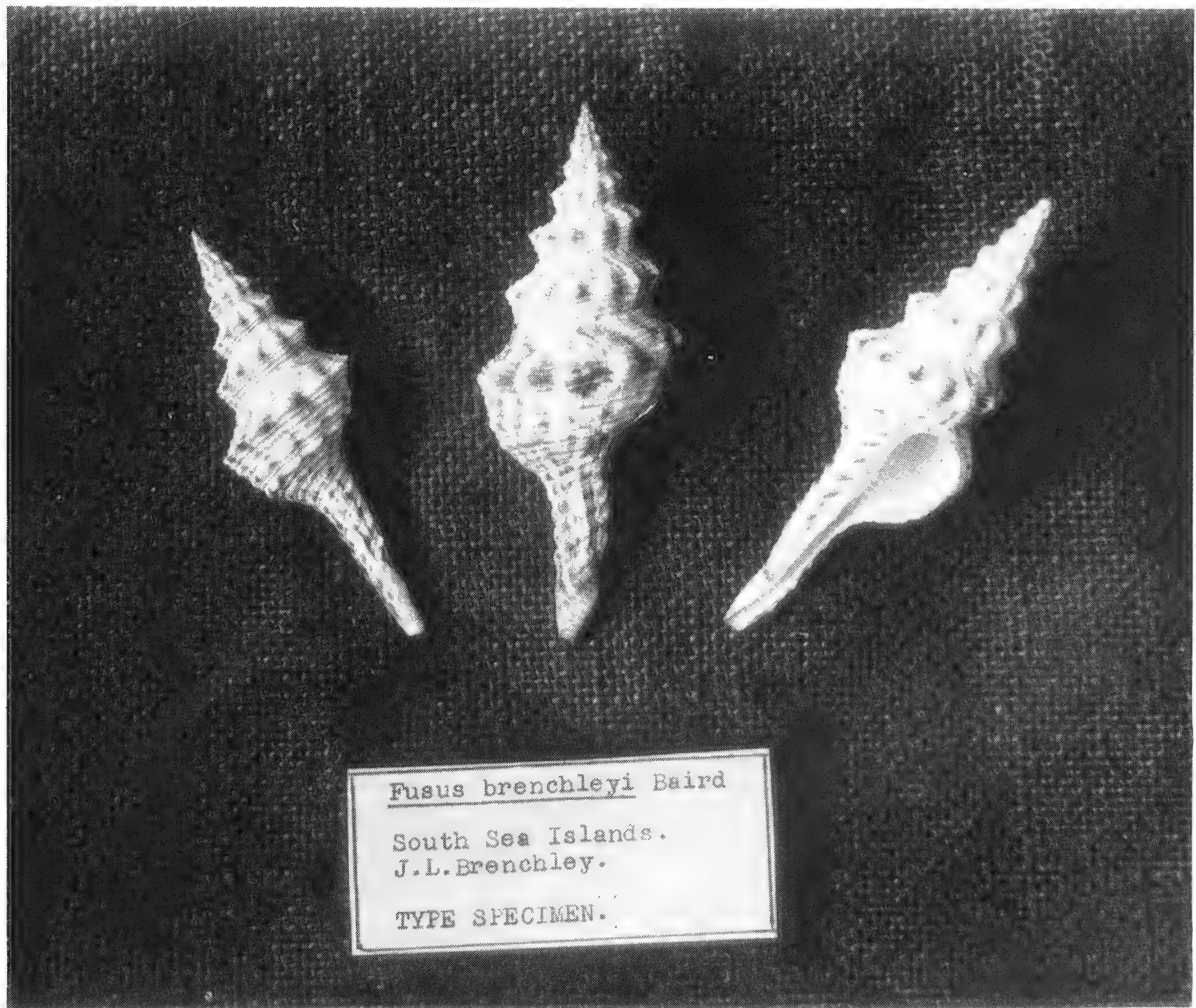


Fig. 3. *Fusus brenchleyi* Baird. Type material of a species named after Brenchley in the Maidstone Museum.

These were eventually taken off display and have been in store for many years, some of them still on their tablets complete with data. The store where the Brenchley shells are now kept was fortunately not affected by the fire which devastated Maidstone Museum in 1977. Before this, new shell cabinets were acquired and plans were made to curate the collection, but the rebuilding of the museum following the fire and subsequent renewal of the public galleries prevented this taking place. A recent grant from the Museums and Galleries Commission administered by the Area Museums Service for South East England under the Biological Collections Project has enabled a start to be made and further grant aid is being sought to complete this.

Following publication of Brenchley's books (1873) and the curation of the collection by Lightfoot, no further work has been done on the Brenchley Collection. It offers an interesting unexploited resource for future students of Pacific island Mollusca. At one stage the collection was stored in boxes scattered in different parts of Maidstone (Philp, pers. comm.) and therefore inaccessible. Even after the collection was brought together in Maidstone Museum it was not in order and could not be easily used for research.

Once the collection is in the cabinets and arranged in taxonomic order it will then be accessible to researchers on Pacific Island faunas and hopefully a species list for the Curaçoa cruise drawn up.

Due to the considerable changes in populations, habitats and extinctions of species this century, some of the items in the collection are not replacable and thus serve as a valuable historical biological data base for Pacific island shells. Two particular examples of groups much depleted this century from this area and represented in the 19th century collection at Maidstone are the land snail genera *Achatinella* and *Partula* of which most species are listed as endangered in the *IUCN Invertebrate Red Data Book* and some thought to be extinct (Wells, Pyle & Collins 1983).

#### PACIFIC ISLAND MOLLUSC FAUNAS

In the nineteenth century potential was realised for the study of natural history on sea voyages and interested Captains of ships were keen to have a naturalist on board: this was often the ship's surgeon. Charles Darwin was to make his mark as a naturalist on HMS Beagle (1831–1836) which led to his theory on evolution. In the Pacific the ship's surgeon R. B. Hinds made collections of shells on HMS Sulphur (1836–1842) and, also under the same Captain, Arthur Adams, ship's surgeon, made collections of shells on HMS Samarang (1843–1846) (Dance 1966, Trew 1992). These were some twenty years before Brenchley's cruise and he does not refer to their work.

The nineteenth century was one of exploration and popular interest in natural history when broad outlines of the marine and non-marine faunas were being established. Woodward (1890) in his book *A Manual of Mollusca* outlined the biogeography and typical mollusc fauna of the Indo-Pacific Marine Province and the more restricted distribution of the non-marine species of the Pacific islands and their affinities to faunas of New Zealand and the Asiatic islands. The tropical marine fauna is known for its large, colourful seashells always popular with collectors – cones, cowries, olives, mitres, volutes, harps, strombs, muricids and giant clams that feature strongly in Brenchley's collection. Some of these, as described in the book (Brenchley 1873) were obtained by barter but others collected by Brenchley himself were accompanied by better data. Non-marine molluscs are less uniform in distribution and island faunas have been the topic of much interest amongst modern malacologists, particularly Solem (1959, 1961, 1962, 1976, 1983 and 1984) who has studied land snails in the field in the New Hebrides, New Caledonia and Solomon Islands. He points out the exceptional species diversity of mollusc faunas on small islands, giving Lord Howe



Island in the Pacific as an example with 50 endemic snails found nowhere else. (Solem & van Bruggen, 1984). The records of Tillier & Clarke (1983) refer to 300–400 species with 99% endemic to New Caledonia. Both of these places are in the area covered by the Curaçoa cruise.

Solem (1959) in reviewing the literature on land molluscan faunas of Pacific islands, commented that the people who collected the material were not mollusc specialists and their collections were worked up and published by others who had not visited the habitat. Brenchley was a collector rather than a conchologist and falls into this category. His book on the Curaçoa cruise seems to have been overlooked and is not listed in Solem's bibliography (1959). Peake (1968) took part in the Royal Society expedition to the Solomon Islands in 1965 (another area visited by Brenchley on the Curaçoa) and he outlines the habitats and molluscan ecology of the islands. The Solomons are dominated by rain forest and have a hot humid climate. Other more recent accounts are given in Parkinson *et al.* (1987), who, having spent some years on Fiji, reported on the loss of native rain forest from sugar plantations and from the introduction of pigs. Two other introductions to Fiji, the Indian Mongoose and the Cane Toad (*Bufo marinus*) have had further devastating effects on the populations of land snails.

Solem (1984) concluded that:

*Studies in the tropics are an urgent necessity if we are to gain an understanding of world diversity for land molluscs . . . the tropics probably contain a fair portion of the total number of land snail species, and much of it is unknown at this time. With the rapid destruction of tropical forests today, probably they will remain so.*

Endemic species limited to a small geographical area, are at potential risk of extinction, especially if there are drastic changes to native vegetation by man or domestic animals and such changes can also affect microclimates. The broadly adapted land snail species with high physiological tolerance are able to survive while the more closely adapted species of narrow habitats are in danger of extinction.

Land snail faunas on remote oceanic islands were established through transport, often by birds, which favours the smaller species. Man's activities, intentionally or unintentionally have introduced other new species, some of which have a harmful influence on the existing fauna. In the Pacific are examples of a carnivorous snail (*Euglandina rosea*) brought in as an unfortunate biological control for the introduced giant African land snails and this has instead devastated existing native populations of *Achatinella* in the Hawaiian Islands and the land snail *Partula*. The species of *Partula* are mostly endemic to their own island and have been the subject of some recent research on genetics. In these cases the laboratory research cultures of the snails have acquired an additional importance of species survival (Tudge 1992). The *IUCN Invertebrate Red Data Book* (Wells, Pyle & Collins 1983), whilst acknowledging the possible effect of overcollecting in the 19th century, now considers the main threats to land snails to be habitat destruction, forest fires and competition from introduced species. Collections and accounts of snail faunas in the last century are important in assessing this threat.

Further curation of the Brenchley Collection, followed by research on Pacific land snail faunas will realise the potential of this data bank at Maidstone which is currently not widely known.

#### ACKNOWLEDGEMENTS

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Eric Philp, former Keeper of Natural History, for assistance in the museum and to Mr Richard Stutely also of the Natural History Department at Maidstone for help with manuscript sources. I am also grateful to the Mollusca Section of the Natural History Museum in London for access to types and library facilities.

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## APPENDIX I BIOGRAPHICAL FOOTNOTES

1. DR WILLIAM BAIRD (1803–1872) was in charge of the shell collections at the British Museum from 1841–1871 (Stearn 1981).
2. HUBERT JOHN ELGAR assisted in the Maidstone Museum and worked under Lightfoot on the Brenchley shells. He left the museum as no promotion was possible but returned in 1892 and became Curator. He was from Maidstone, Kent. Died 1931, aged 76.

# CHATFIELD: SHELL COLLECTIONS IN THE MAIDSTONE MUSEUM

3. JOHN BRAZIER (1842–1930) was an Australian shell collector who was on the HMS Curaçoa. He published on shells in the *Proceedings of the Zoological Society of London* and discovered new species described by Angas who also named new species after him (Angas 1869 and 1877).
4. H. J. VEITCH was son of the well known nurseryman of Chelsea and he was on the HMS Curaçoa collecting plants. A Harry J Veitch from the Royal Exotic Nursery, Chelsea donated shells from the Phillipine Islands to the British Museum in 1871. (Registration number 71.11.18, 1–17)
5. LT. H. FESTING, Midshipman of the Curaçoa. He lived at Loose, Kent and the Maidstone Museum accessions show shells from the South Seas given by him in 1873, 1877 and 1878.

## APPENDIX 2

### TYPES OF BAIRD’S SPECIES IN COLLECTIONS AT MAIDSTONE MUSEUM AND LONDON

New species of molluscs from the Pacific collected by Julius Brenchley and described by Dr Baird at the British Museum are included in the Appendix to: *Jottings during the Cruise of HMS Curaçoa among the South Sea Islands in 1865*. By Julius L. Brenchley, Longmans, Green & Co, London, 1873.

Species	Types located	
	Maidstone	London
<i>Fusus (Colus) similis</i> , Baird Pl. XXXVI	—	+
<i>Fusus (Colus) brenchleyi</i> , Baird Pl. XXXVII Figs. 1,2	+	+
<i>Defranchia albo-strigata</i> , Baird Pl. XXXVII Figs. 3,4	—	+
<i>Terebra (Leiostoma) parva</i> , Baird Pl. XXXVII Figs. 5,6	—	+ <sup>1</sup>
<i>Nassa bifaria</i> , Baird Pl. XXXVIII Figs. 1,2	—	+
<i>Phasianella wisemanni</i> , Baird Pl. XXXVIII Figs. 3,4	—	+
<i>Stylifer dubius</i> , Baird Pl. XXXVIII Figs. 5,6	—	+
<i>Neritina subrugata</i> , Baird Pl. XXXVIII Figs. 7,8,9	+	+
<i>Nerita stricta</i> , Baird Pl. XXXVIII Figs. 10,11	—	+
<i>Nerita novae-caledoniae</i> , Baird Pl. XXXVIII Figs. 12,13	—	+
<i>Hydrocena similis</i> , Baird Pl. XXXIX Figs. 1,2	—	+
<i>Realia (Omphalotropis) laevis</i> , Baird Pl. XXXIX Figs. 3,4	+	—
<i>R. (Omphalotropis) vavauensis</i> , Baird Pl. XXXIX Figs. 5,6	+	+
<i>R. (Omphalotropis) bicarinata</i> , Baird Pl. XXXIX Figs. 7,8	+	+
<i>Melampus (Tifata) ovuloides</i> , Baird Pl. XXXIX Figs. 9,10	+	—
<i>Melania brenchleyi</i> , Baird Pl. XL Figs. 1,2	+	—
var <i>delicatula</i> Figs. 3,4	+	—
<i>M. cylindroides</i> , Baird Pl. XL Figs. 5,6	—	+
<i>Chiton (Onithochiton) amicorum</i> , Baird Pl. XL Fig. 7	+	+
<i>Helix laqueata</i> , Baird Pl. XL Figs. 8,9	+	+
<i>H. vavauensis</i> , Baird Pl. XL Figs. 10,11	—	—
<i>H. samoensis</i> , Baird Pl. XL Figs. 12,13	+	+
<i>Helicina brenchleyi</i> , Baird Pl. XLI Figs. 1,2	+	+
<i>Helicina fulgurata</i> , Baird Pl. XLI Figs. 3,4	—	— <sup>2</sup>
<i>H. multifasciata</i> , Baird Pl. XLI Figs. 5,6	—	+
<i>H. julii</i> , Baird Pl. XLI Figs. 7,8	+	+
<i>H. strigata</i> , Baird Pl. XLI Figs. 9,10	+	+
<i>H. novae caledoniae</i> , Baird [not figured]	—	+
<i>Tellina novae caledonia</i> , Baird Pl. XLI Figs. 11,12	—	+
<i>T. bifaria</i> , Baird Pl. XLI Fig. 13	—	+
<i>Venus roseo-tincta</i> , Baird Pl. XLII Figs. 1,2,3	+	+
<i>Arca novae caledoniae</i> , Baird Pl. XLII Fig. 4	—	+
<i>A. (Byssarca) dubia</i> , Baird Pl. XLII Figs. 5,6	—	+
<i>Pecten similis</i> , Baird Pl. XLII Fig. 7	—	—
<i>Perna (Isognomon) samoensis</i> , Baird Pl. XLII Fig. 8	—	+

Notes:  
 1: A lectotype and paralectotypes of *Terebra parva* have been selected by Cernohorsky (1969).  
 2: The only specimen and type was lost by the artist (Brenchley 1873, p. 454). Manuscript note in Lightfoot’s catalogue at Maidstone Museum on *Helicina fulgurata*: *only one specimen in bottle – sent it to the British Museum Dec’ 14 1870*  
 The specimens on which these species were founded were presented to the British Museum by Julius Brenchley and their transport recorded in a notebook by Lightfoot.





# THE MARGINELLIDAE OF ANGOLA: THE GENUS *MARGINELLA*

S. GOFAS<sup>1</sup> AND F. FERNANDES<sup>2</sup>

**Abstract:** The species of the genus *Marginella* (Gastropoda, Marginellidae) from coastal Angola are reviewed. *Marginella gemmula* Bavay, 1913 is the only previously described Angolan species of a complex which also includes *M. luculenta* n. sp., *M. simulata* n. sp. and *M. undulans* n. sp. *Marginella huberti* Clover, 1972 and *M. lucani* Jousseaume, 1884 are redescribed, *M. carquejai* n. sp., *M. fumigata* and *M. marimba* are described.

**Résumé:** Les espèces du genre *Marginella* (Gastropoda, Marginellidae) du littoral de l'Angola sont révisées. *Marginella gemmula* Bavay, 1913 est la seule espèce angolaise décrite jusqu'ici, dans un complexe qui comprend aussi *M. luculenta* n. sp., *M. simulata* n. sp. et *M. undulans* n. sp. *Marginella huberti* Clover, 1972 et *M. lucani* Jousseaume, 1884 sont redécrites, *M. carquejai* n. sp., *M. fumigata* et *M. marimba* sont décrites.

**Resumo:** As espécies do género *Marginella* (Gastropoda, Marginellidae) do litoral de Angola são revistas. *Marginella gemmula* Bavay, 1913 é a única espécie angolana previamente descrita num complexo que também inclui a *M. luculenta* n. sp., *M. simulata* n. sp. e *M. undulans* n. sp. *Marginella huberti* Clover, 1972 e *M. lucani* Jousseaume, 1884 são redescritas, *M. carquejai* n. sp., *M. fumigata* e *M. marimba* são descritas.

**Key words:** Taxonomy, Marginellidae, West Africa, sibling species, endemism.

## INTRODUCTION

This paper continues the revision of Angolan Marginellidae, that started with the genera *Gibberula* (Gofas 1989) and *Volvarina* (Gofas & Fernandes 1992). The reader is referred to the first paper for collecting methods and a map of collecting localities (in the meantime the city of Moçâmedes has been renamed Namibe).

Unlike some well-known species from Mauritania or Senegal, most of the Angolan species of *Marginella* are rare, even in the proper habitat, and are represented in our material by few specimens. This work has been further hampered by the theft from the Paris Museum of some of the best specimens, including the unique would-be holotype of a spectacular species of which now only a photograph is left (Gofas 1987). We know from some fragmentary material that more species are still to be discovered, especially if the deeper rocky bottoms could be properly sampled.

## GENUS *MARGINELLA* LAMARCK, 1799

The type species of *Marginella* is *Voluta glabella* Linné, 1758, by monotypy. The genus *Marginella* as understood here (including *Glabella* Swainson, 1840, type species *Marginella bifasciata* Lamarck, 1822, SD Redfield, 1871) is mainly distributed on the continental shelf

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of West and South Africa, with a lesser number of species in the Indian Ocean and in the tropical Western Atlantic. The name has also been widely used in the literature in a broader sense to include virtually any marginellid.

*Shell characters:* Shell 5 to 50 mm in length, with moderately elevated spire and glossy porcellanous surface, generally colourful. Columella with four definite, subequal plaits on its anterior half. Outer lip thickened, generally denticulated inside. Siphonal canal not deeply incised.

*Head-foot and mantle:* Head bifurcated, with slender tentacles and eyes in small bulges lateral to the base of the tentacles. Siphon large and protruding over the head. Foot large, creeping flat on the surface, slightly longer than the shell when extended. Mantle not visible through the shell and hardly extending over it when the animal is moving (sometimes a small lobe can be seen on the left side).

*Radula:* No radula has been reported so far in the species of *Marginella* s. str. examined (Graham 1966, Ponder 1970, Kilburn 1977, Gofas & Fernandes 1988).

***Marginella gemmula* Bavay in Dautzenberg, 1913 (Figs. 1–4, 9, 21)**

*Marginella gemmula* Bavay, in Dautzenberg, 1913, p. 20–21, pl. 1 fig. 17–18.

*Type material:* 1 figured syntype, here designated as lectotype, in MNHN.

*Type locality:* Praia Amelia.

*Other material examined:* Ponta das Lagostas (Luanda), 0–1 m: 8 shells. Praia Etambar (Luanda), 0–1 m: numerous specimens. Caotinha (Benguela), 0–1 m: 11 specimens. Baia dos Limagens, 0–2 m: numerous specimens. Baia de Santa Maria, 0–2 m: 27 specimens and 1 shell; 8–10 m: 1 shell. Lucira (Praia do Cesar): 9 specimens. Chapeu Armado, 0–1 m: 23 adult specimens + juveniles. São Nicolau, 0–1 m: 6 specimens (2 juv.). Praia das Conchas (Namibe), intertidal: 4 specimens. Praia Amelia, 0–1 m: 1 specimen (all MNHN).

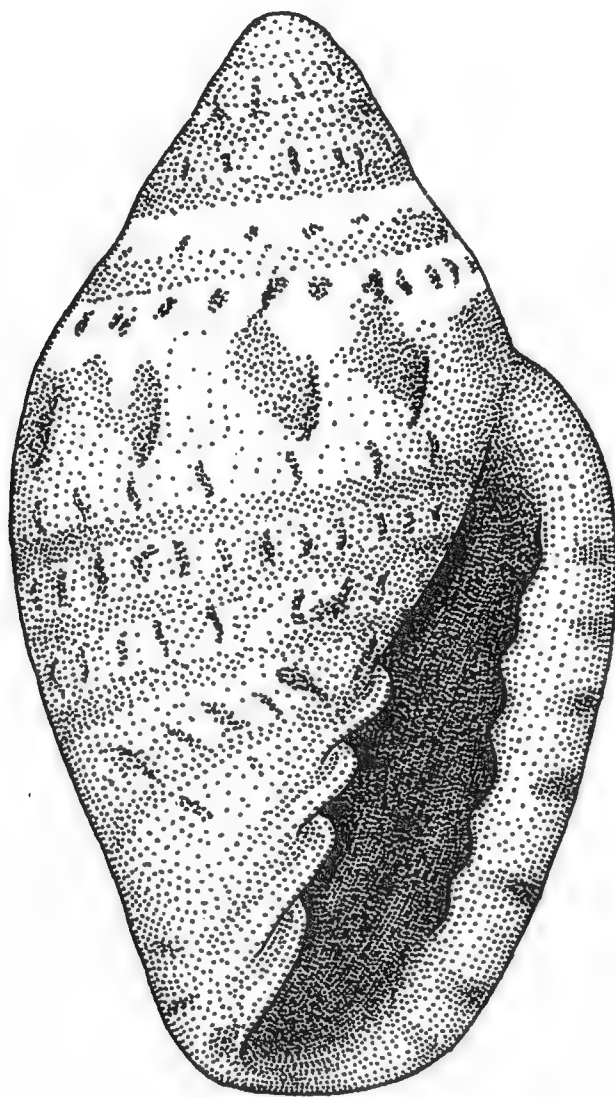


Fig. 1. *Marginella gemmula* Bavay: lectotype from Praia Amelia. Actual size 5.2 mm.

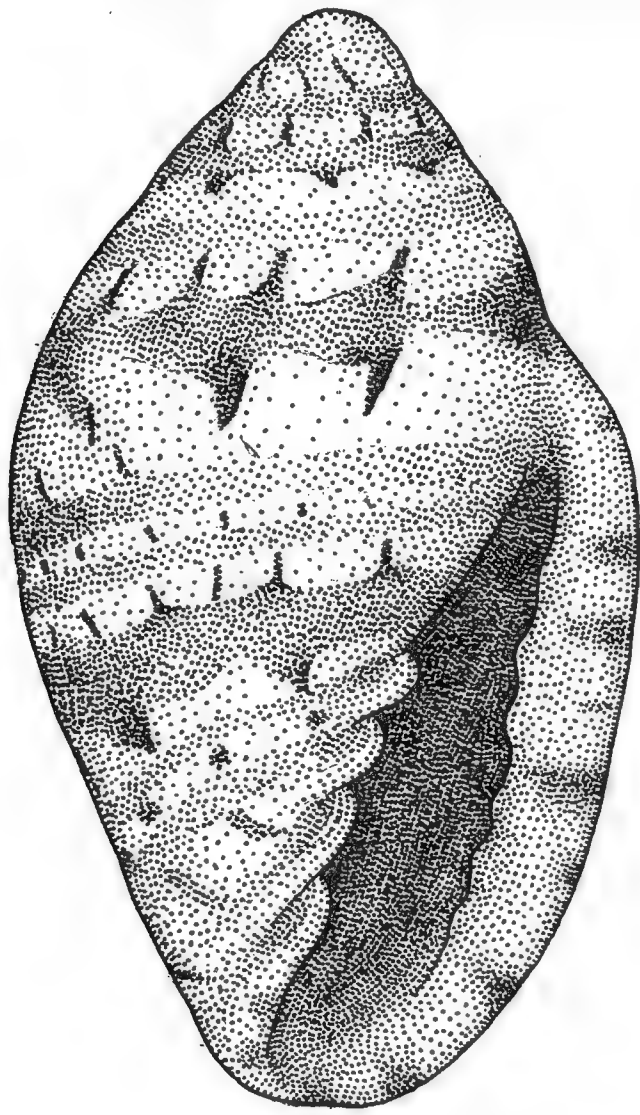


Fig. 2. *Marginella gemmula* Bavay: specimen from Praia das Conchas. Actual size 5.5 mm.

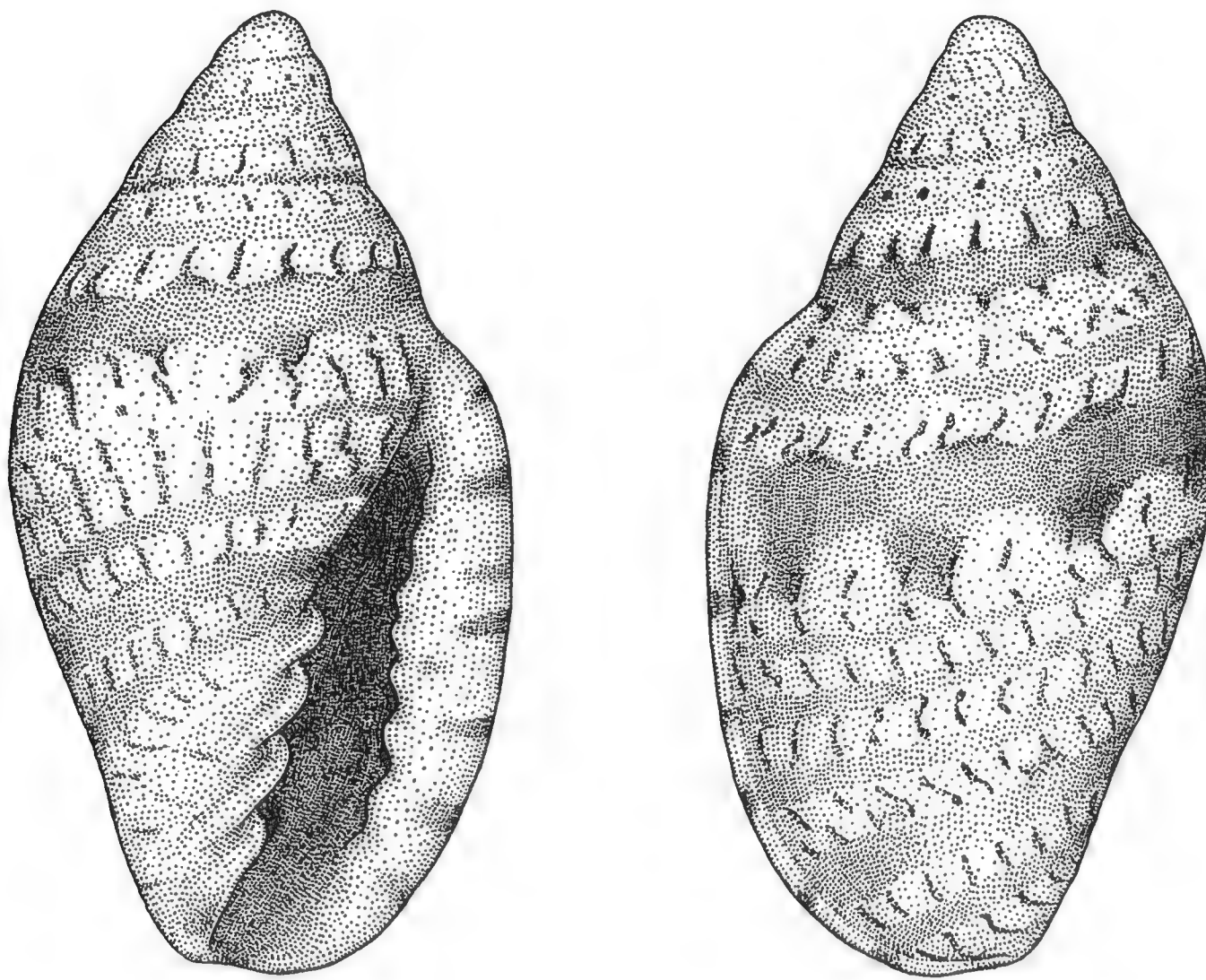


Fig. 3. *Marginella gemmula* Bavay: specimen from Luanda (Praia Etambar). Actual size 6.6 mm.

*Description:* Shell 5 to 6.6 mm in length, 3 to 3.4 mm in greatest diameter (lectotype  $5.2 \times 3$  mm), with moderately high spire and indistinct suture. Outer lip very thick, with 6–12 uneven denticles on the inner side. Aperture moderately narrow, tapering posteriorly.

Apical whorl whitish to tan in colour, with the suture underlined by a dark line; next whorl with some oblique dark streaks.

Colour pattern of teleoconch: a broad spiral zone of dark greenish brown towards the



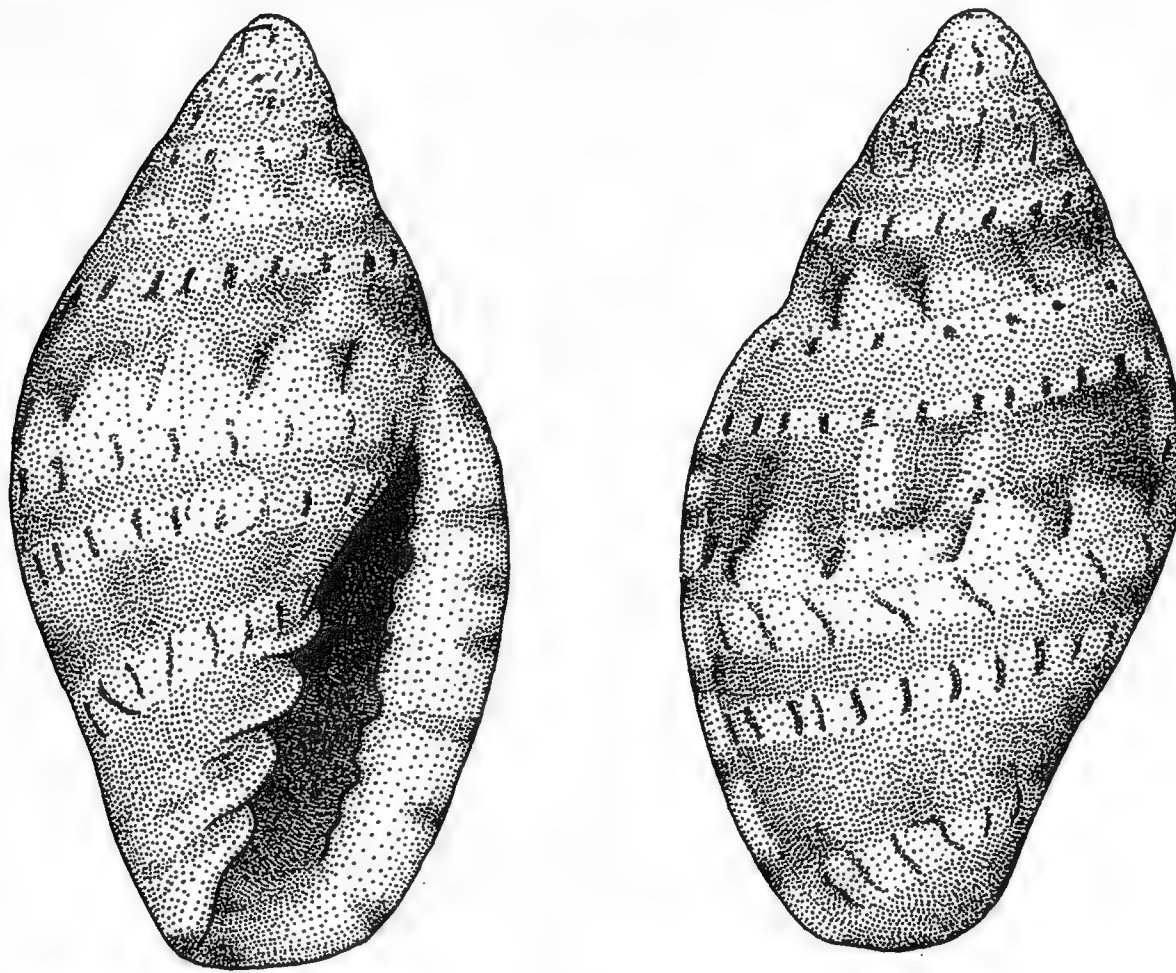


Fig. 4. *Marginella gemmula* Bavay: specimen from Bay of Lucira (Praia do Cesar). Actual size 5.8 mm.

broadest part of the body whorl, continuing a pattern on the spire whorls which is visible along the suture. Darker flames or patches projecting alternately on each side of this zone, and merging with a spiral series of short oblique streaks of a dark, almost black colour. Similar spiral series of streaks, and spiral bands of light pinkish to greenish brown colour alternating on the anterior part of the body whorl. Another spiral band of pinkish or greenish brown and another spiral series of streaks (or dots) between the broad dark band and the suture; colour pattern of previous whorl visible by transparency beneath the suture. Outer lip with a series of dark blotches, spaced evenly and mostly terminating the light, continuous spiral bands.

Head, tentacles, siphon and foot uniformly covered with small yellow dots.

*Habitat:* In the infralittoral algal mat, on rocks among small algae trapping muddy sediment; low intertidal to shallow (0–2 m) subtidal. The lectotype, a shell dredged at 15–35 m, is certainly transported downslope.

*Remarks:* This species, and the three following, belong to a species complex which also includes four species from São Tomé and Príncipe (Gofas & Fernandes 1988), *M. bavayi* Dautzenberg, 1910 and *M. festiva* Kiener, 1841 from Senegal, *Marginella stuarti* Kilburn, 1977 from Namibia and *Marginella cloveri* Rios and Matthews, 1972 from Brazil. The range of *M. festiva* was reported as unknown by Gofas & Fernandes (1988) but its occurrence in Senegal is now ascertained (personal communication by Marcel Pin, Dakar).

***Marginella luculenta* n. sp. (Figs. 5, 6, 22)**

*Type material:* Holotype and 2 paratypes (MNHN), 4 paratypes (BMNH, IIT, NM, UAN) and 20 paratypes (FF) from the type locality.

*Type locality:* Off Ilha de Luanda, 50 m.

*Other material examined:* Ponta das Lagostas (Luanda), 5–20 m: 2 shells (MNHN) and 35 specimens (FF). Corimba, 10–20 m: 1 specimen. Caotinha (Benguela), 0–2 m: 1 specimen. Santa Maria, 30–40 m: 6 juveniles (MNHN). Lucira (Santa Marta), 40 m: 2 shells and juveniles (MNHN). Lucira, 70 m: 1 specimen (MNHN). São Nicolau, 0–1 m: 1 shell

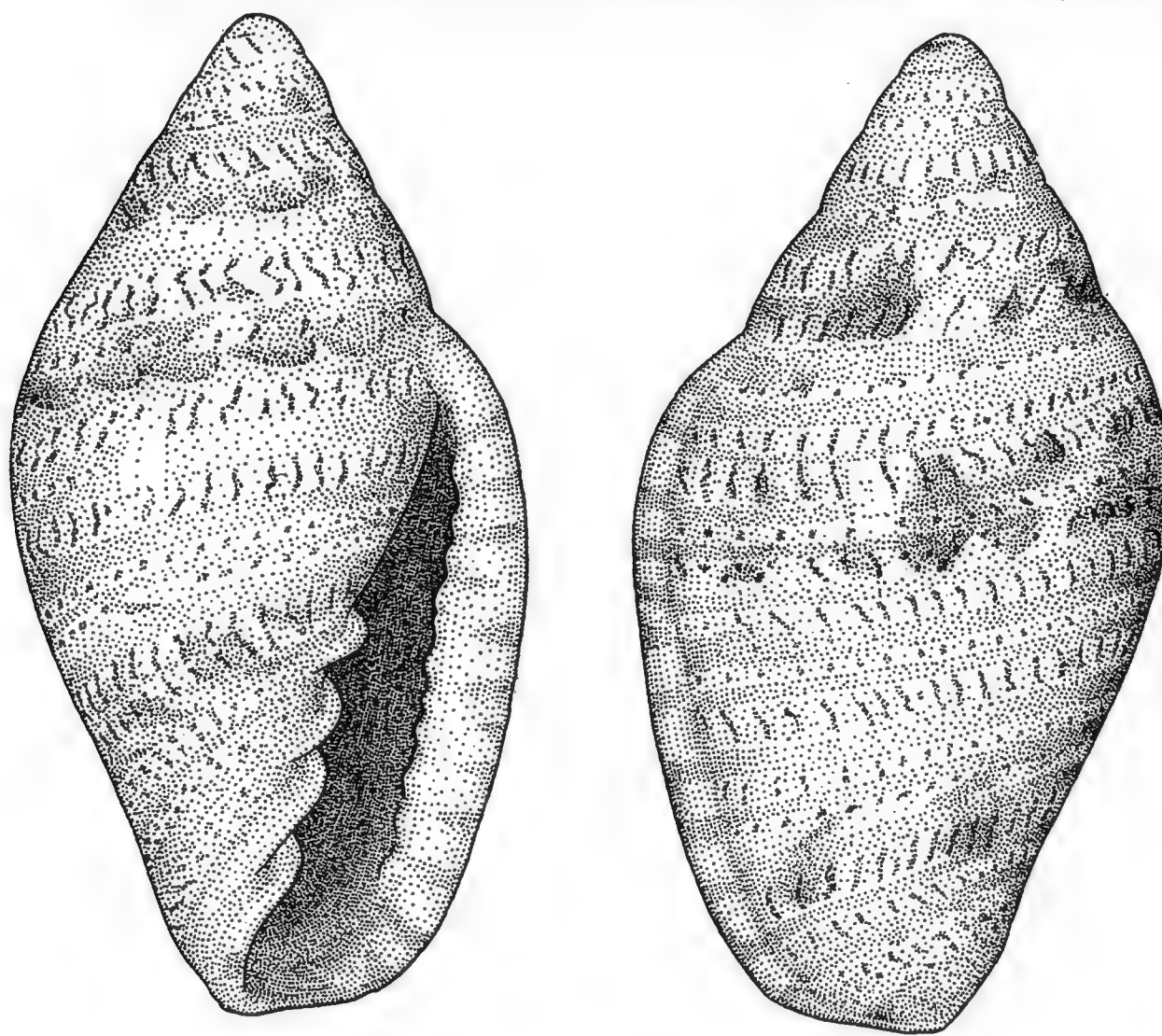


Fig. 5. *Marginella luculenta* n. sp.: holotype from off Ilha de Luanda. Actual size 11.0 mm.

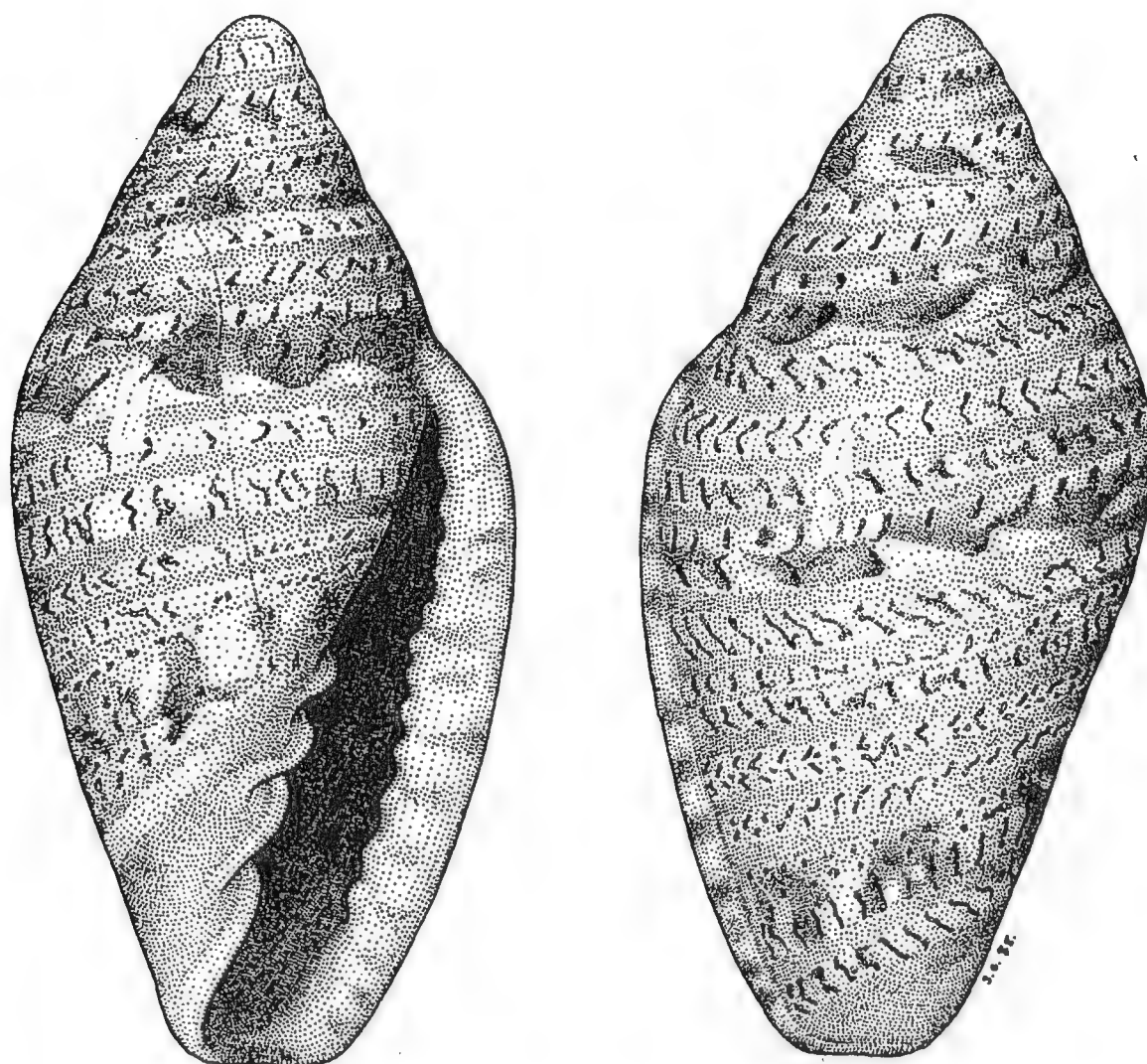


Fig. 6. *Marginella luculenta* n. sp.: specimen from Bay of Lucira. Actual size 12.5 mm.

(MNHN). Praia Amelia, 2–5 m: 1 specimen (MNHN). Saco Mar, Namibe, 2–10 m: numerous specimens (FF).

*Description:* Shell 9 to 12.5 mm in length, 5 to 6.5 mm in greatest diameter (holotype 11.0 × 5.8 mm), with moderately high spire and indistinct suture. Outer lip very thick, with 12–13 denticles on the inner side. Aperture quite narrow, tapering posteriorly.

Apical whorl tawny, with the sutural area occasionally slightly tinged with red-brown;

next whorl marked with delicate, oblique dark streaks. Colour pattern of teleconch: a broad spiral zone with greenish brown blotches mixed with oblique black streaks, anteriorly to the broadest part of the body whorl, continuing a pattern on the spire whorls which is visible along the suture. Dark streaks and blotches projecting into a white band anterior to this zone. Several spiral series of streaks, and spiral bands of pinkish to greenish brown colour alternating on the anterior part of the body whorl, with also a few brown blotches along the anterior one-third. Two more spiral series of streaks (or dots) alternating with spiral bands between the broad dark area and the suture. Colour pattern of previous whorl visible by transparency beneath the suture. Outer lip with a series of pink or tawny blotches, spaced evenly and mostly terminating the light, continuous spiral bands.

Head, siphon and foot uniformly covered with small yellow dots. Tentacles with fewer similar yellow dots, concentrated towards their terminal part.

*Habitat:* In shell gravel at 15 to 70 m in Northern Angola; also in shallower water (from 1 m) in shell sand among rocks in Southern Angola.

*Remarks:* This is the largest known West African species of the *M. festiva* complex. The specimens from shallower water (Corimba, 15–20 m and littoral localities in the South) are stouter in shape and differ in having yellow spots on the tentacles as dense as those on the foot and siphon. They are otherwise similar and have been provisionally retained within the variability of *M. luculenta*.

***Marginella simulata* n.sp. (Figs. 7, 8, 9)**

*Type material:* Holotype (MNHN), 6 paratypes (juveniles, MNHN) and 6 paratypes (1 BMNH, 1 IIT, 1 NM, 1 UAN 2 FF) all collected alive from the type locality.

*Type locality:* Bay of Lucira (Bissonga), 20 m.

*Other material examined:* Bay of Limagens, 0–2 m: 1 shell (MNHN). Bay of Santa Maria, 1 shell (MNHN). Off Lucira (Santa Marta), 40 m: 17 shells (MNHN). Saco Mar, Namibe, 2–10 m: 12 specimens (MNHN) and numerous specimens (FF).

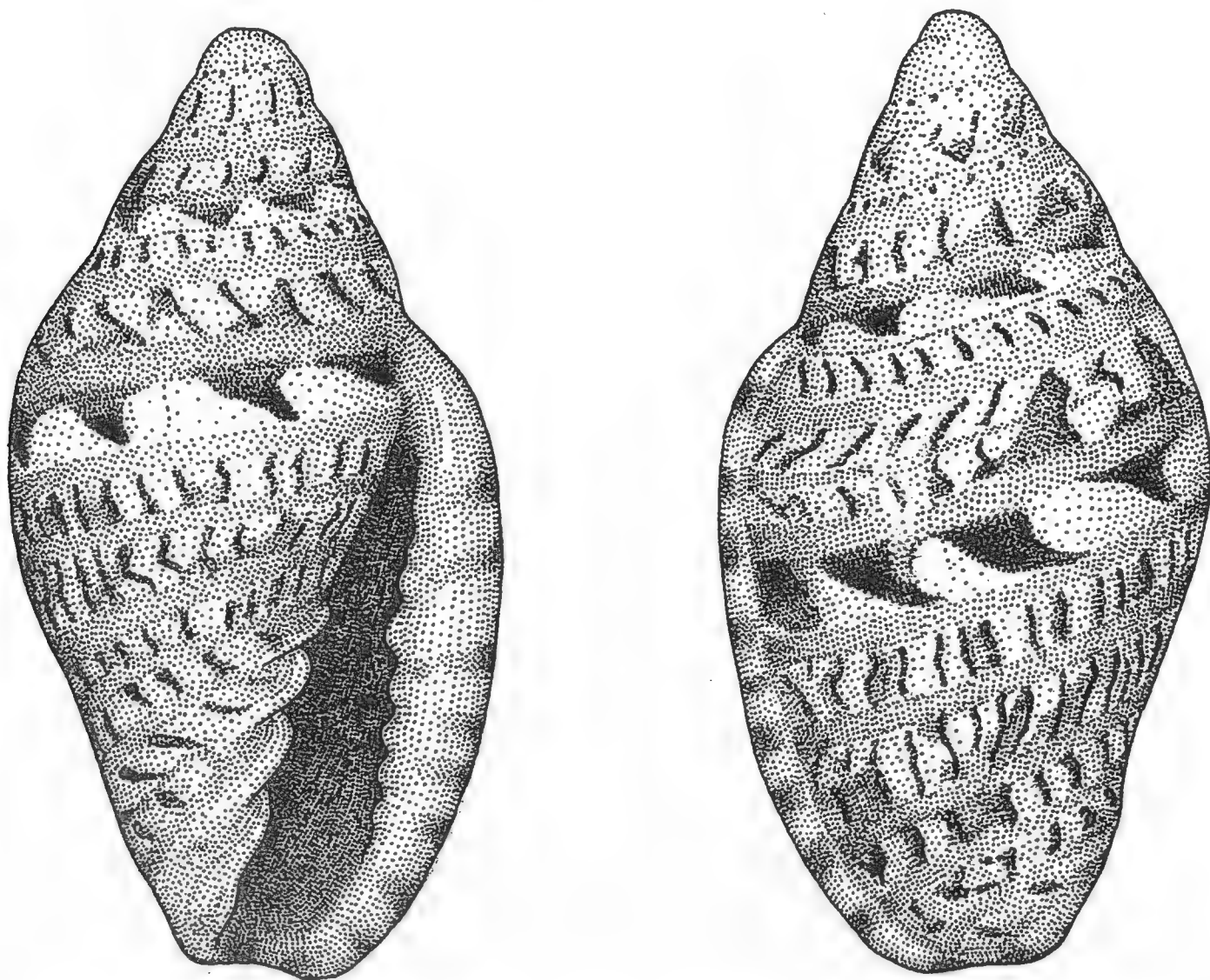


Fig. 7. *Marginella simulata* n. sp.: holotype from Bay of Lucira (Bissonga). Actual size 5.4 mm.



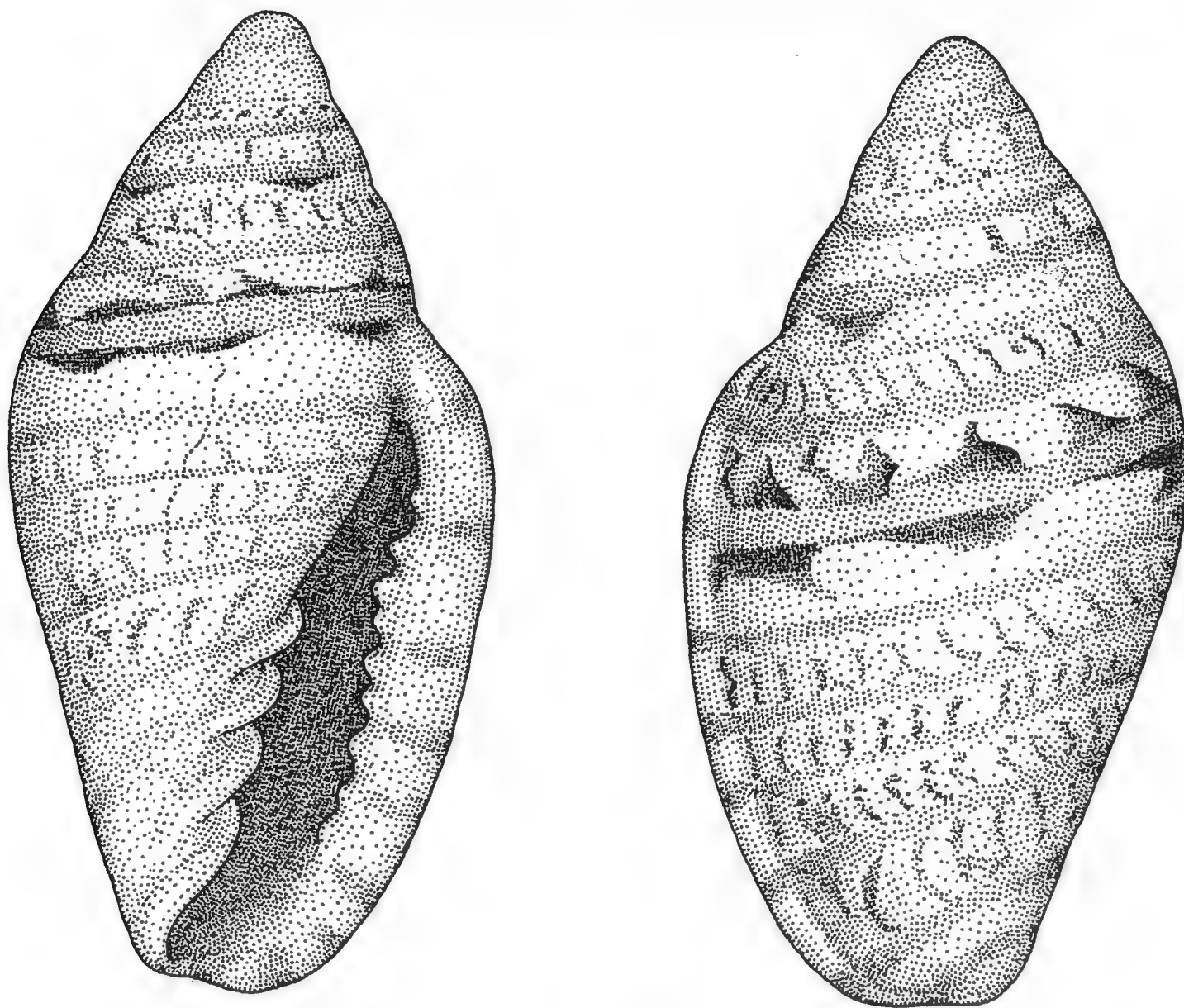


Fig. 8. *Marginella simulata* n. sp.: specimen from Bay of Limagens. Actual size 5.8 mm.

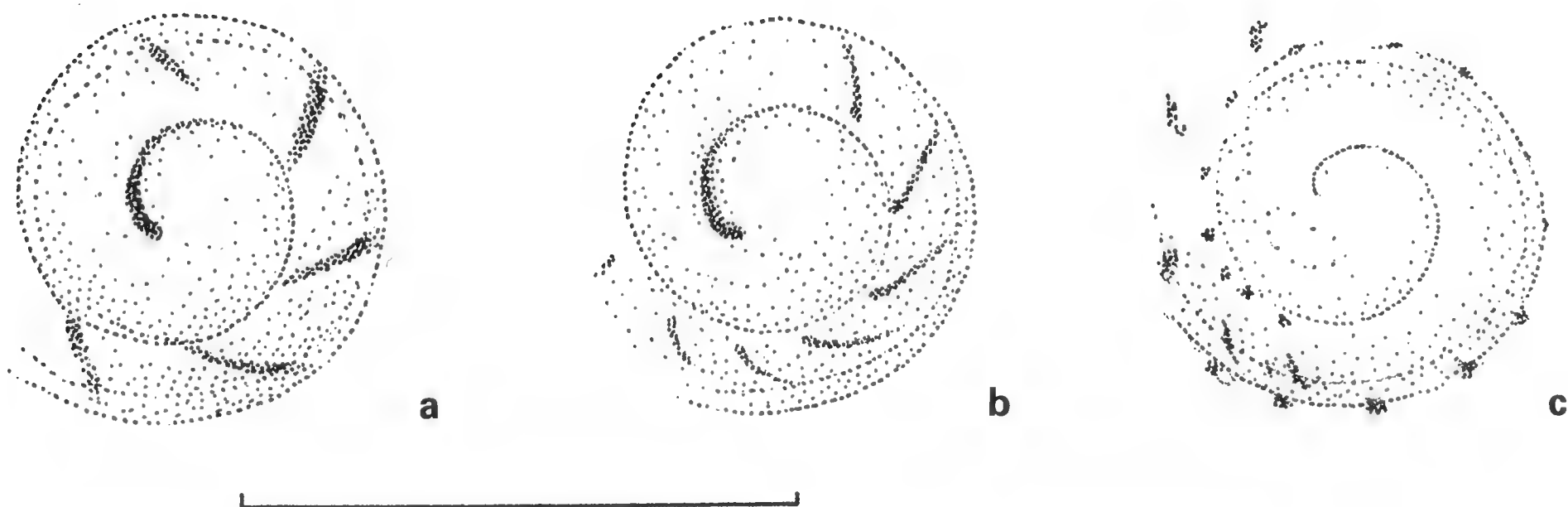


Fig. 9. Comparison of apical whorls in *Marginella gemmula* (a,b) and in *Marginella simulata* n. sp. (c). Apical views, scale bar is 1 mm.

**Description:** Shell 5 to 6.6 mm in length, 2.7 to 3.4 mm in greatest diameter (holotype 5.4 × 2.8 mm), with moderately high spire and indistinct suture. Outer lip very thick, with 8–10 uneven denticles on the inner side. Aperture quite narrow, tapering posteriorly.

Apical whorl pink, with no dark line along the suture; next whorl with some small dark dots along the suture.

Colour pattern of teleoconch: a spiral zone of dark greenish brown towards the broadest part of the body whorl, continuing a pattern on the spire whorls which is visible along the suture. Darker flames or patches projecting alternately on each side of this zone, merging with a spiral series of short oblique black streaks on its posterior, but not on its anterior edge. Spiral series of black/dark brown streaks, and pink spiral bands alternating on the anterior part of the body whorl. Another spiral band of pinkish or greenish brown and another spiral series of streaks (or dots) between the broad dark band and the suture. Colour pattern of

previous whorl visible by transparency beneath the suture. Outer lip with a series of dark blotches, spaced evenly and mostly terminating the pink, continuous spiral bands. Animal not observed.

*Habitat*: On a soft bottom in a sheltered bay, in 2–20 m

*Remarks*: This species is superficially similar to *M. gemmula* but is sympatric with it and consistently different by several chromatic characters of the shell: the early whorls are pink instead of pale buff, and lack a black line along the suture. The pattern of greenish flames on the body whorl does not merge anteriorly with a row of dark streaks, as it does in *M. gemmula*, and there are more rows of dark streaks on the anterior part of the body whorl. It shares with *M. undulans* the preference for a soft bottom habitat, but the two species are distinguished by a more slender outline and taller spire in *M. simulata*. The population from which the holotype has been selected grows to a small size (maximum  $6 \times 3$  mm) and is brightly coloured. Other populations examined (e.g. Saco Mar) grow to a slightly larger size ( $6.6 \times 3.4$  mm) and have a paler shell.

***Marginella undulans* n.sp. (Figs. 10, 23)**

*Type material*: Holotype (MNHN), 4 paratypes (BMNH, IIT, NM, UAN) and 20 paratypes (FF), all from the type locality.

*Type locality*: Praia Amelia, 2–5 m.

*Other material examined*: Farol das Lagostas, Luanda, 10–20 m: 2 shells (FF). Caotinha: 1 shell (MNHN). Bay of Santa Maria, 1–2 m: 1 shell (MNHN). Saco Mar, Namibe, 2–5 m: numerous specimens (FF).

*Description*: Shell 5 to 6.5 mm in length, 3 to 3.4 mm in greatest diameter (holotype  $6.4 \times 3.7$  mm), with moderately high spire and indistinct suture. Outer lip very thick, with 10–11 uneven denticles on the inner side. Aperture moderately narrow, tapering posteriorly.

Apical whorl tinged with pale pink, next whorl also with some oblique dark streaks.

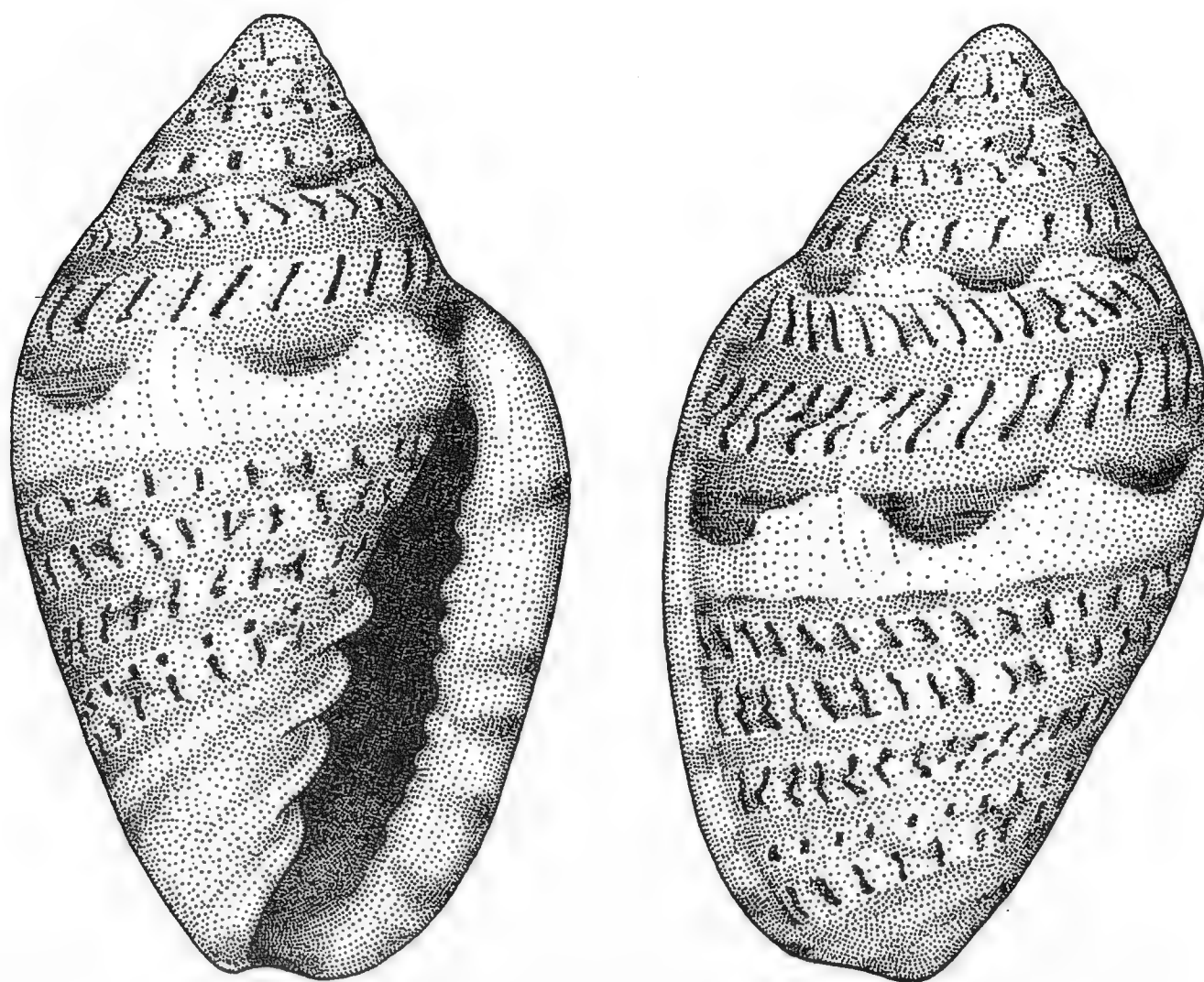


Fig. 10. *Marginella undulans* n. sp.: holotype from Praia Amelia. Actual size 6.4 mm.

Colour pattern of teleoconch: a broad spiral zone towards the broadest part of the body whorl with a scalloped dark design on a white background, bordered posteriorly by a brownish to greenish band. Between this and the suture, two rows of dark, almost black oblique streaks separated by another greenish band. Similar spiral series of streaks, and spiral bands of light pinkish to greenish brown colour alternating on the anterior part of the body whorl. Scalloped design on the body whorl continuing a pattern on the spire whorls which is seen by transparency beneath the suture.

Outer lip with a series of dark blotches, terminating the brownish, continuous spiral bands; some of these blotches extending inside the aperture.

Head and foot uniformly covered with small yellow dots, except for the axial zone on the posterior part of the foot, bearing a large, cloudy white blotch. Siphon opaque white in colour.

*Habitat*: In sediment covering large rocky platforms in sheltered bays; always subtidal. The living animals are buried just below the surface of the sediment.

*Remarks*: This species, found sympatrically with *M. gemmula*, is distinguished from others of the group by the opaque white siphon and the peculiar design of the spiral band on the shell. It is most similar to *M. simulata*, but differs in its much stouter profile.

*Marginella stuarti* Kilburn, 1977 from Walvis Bay and Swakopmund (Namibia) is related but differs in being larger, with a still shorter spire, which is more shouldered. The colour pattern of the foot of *M. undulans* is also different from that ("blotched with grey") reported for *M. stuarti* by Kilburn (1977).

***Marginella huberti* Clover, 1972 (Figs. 11, 12, 13)**

*Marginella huberti* Clover, 1972: 503–504

*Type material*: Holotype (not seen): Manchester Museum n° EE 3659. Paratype 1 (not seen)

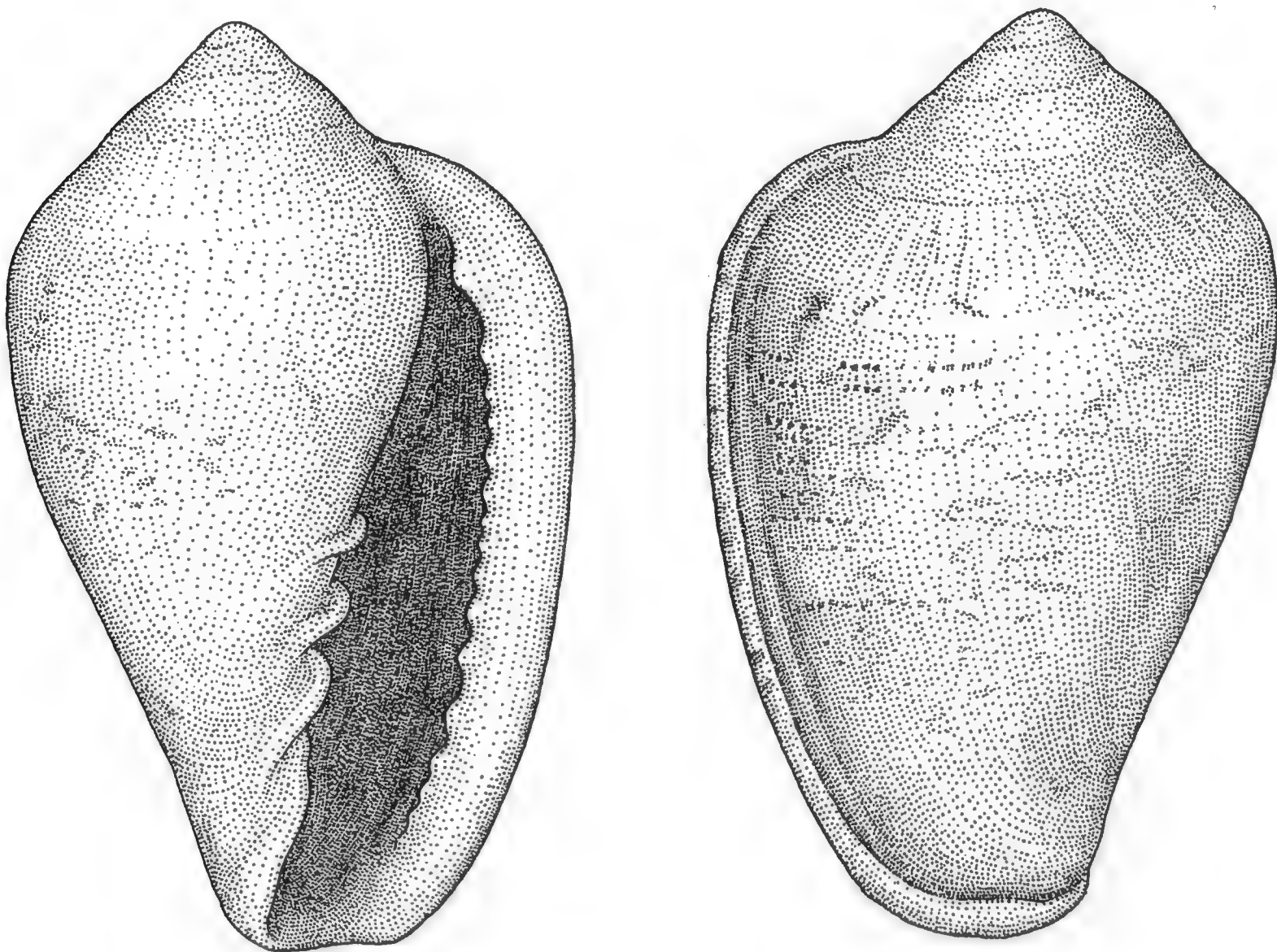


Fig. 11. *Marginella huberti*: paratype from Luanda. Actual size 17.9 mm.



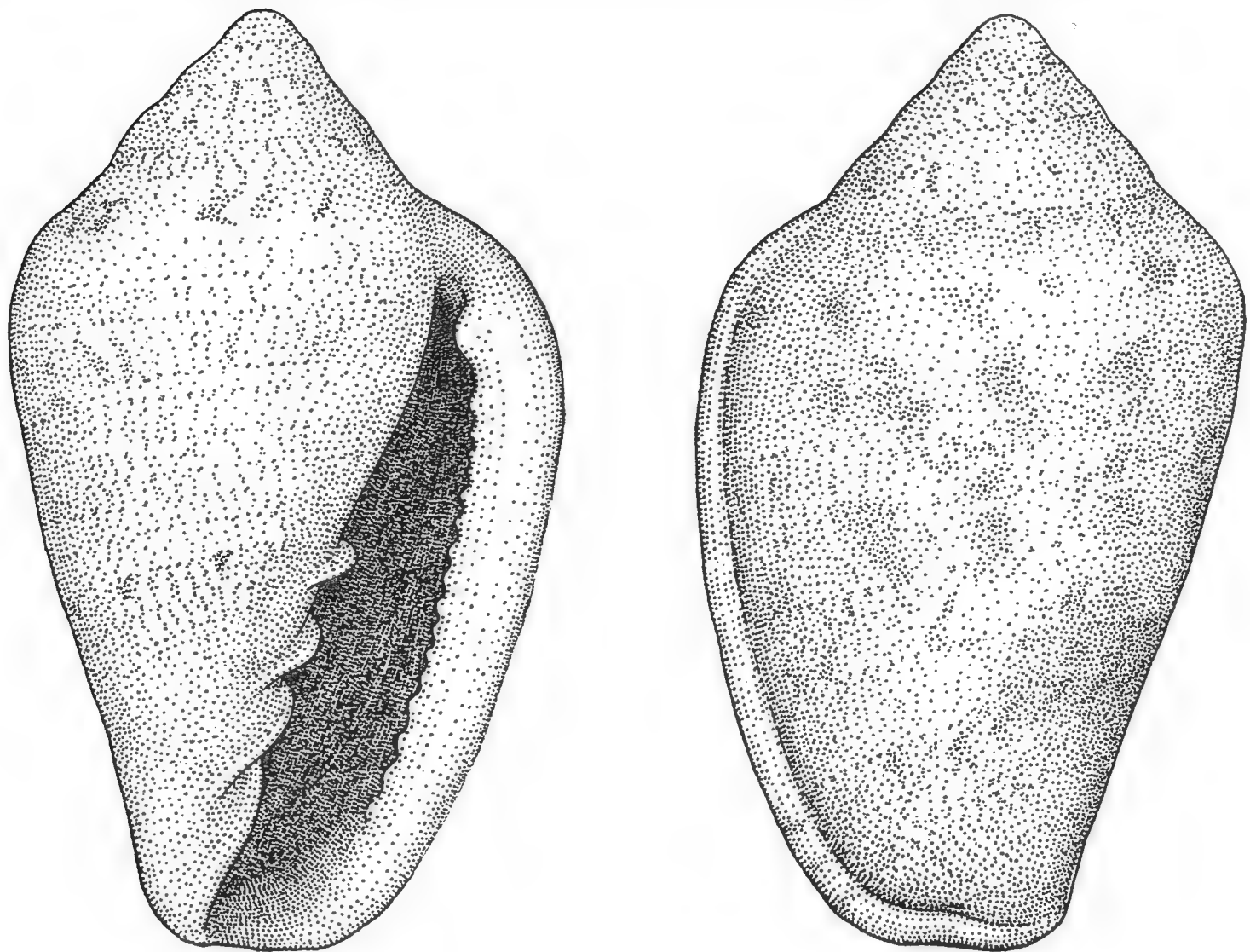


Fig. 12. *Marginella huberti* Clover: shell from Angola (collection M. C. Macedo). Actual size 17.9 mm.

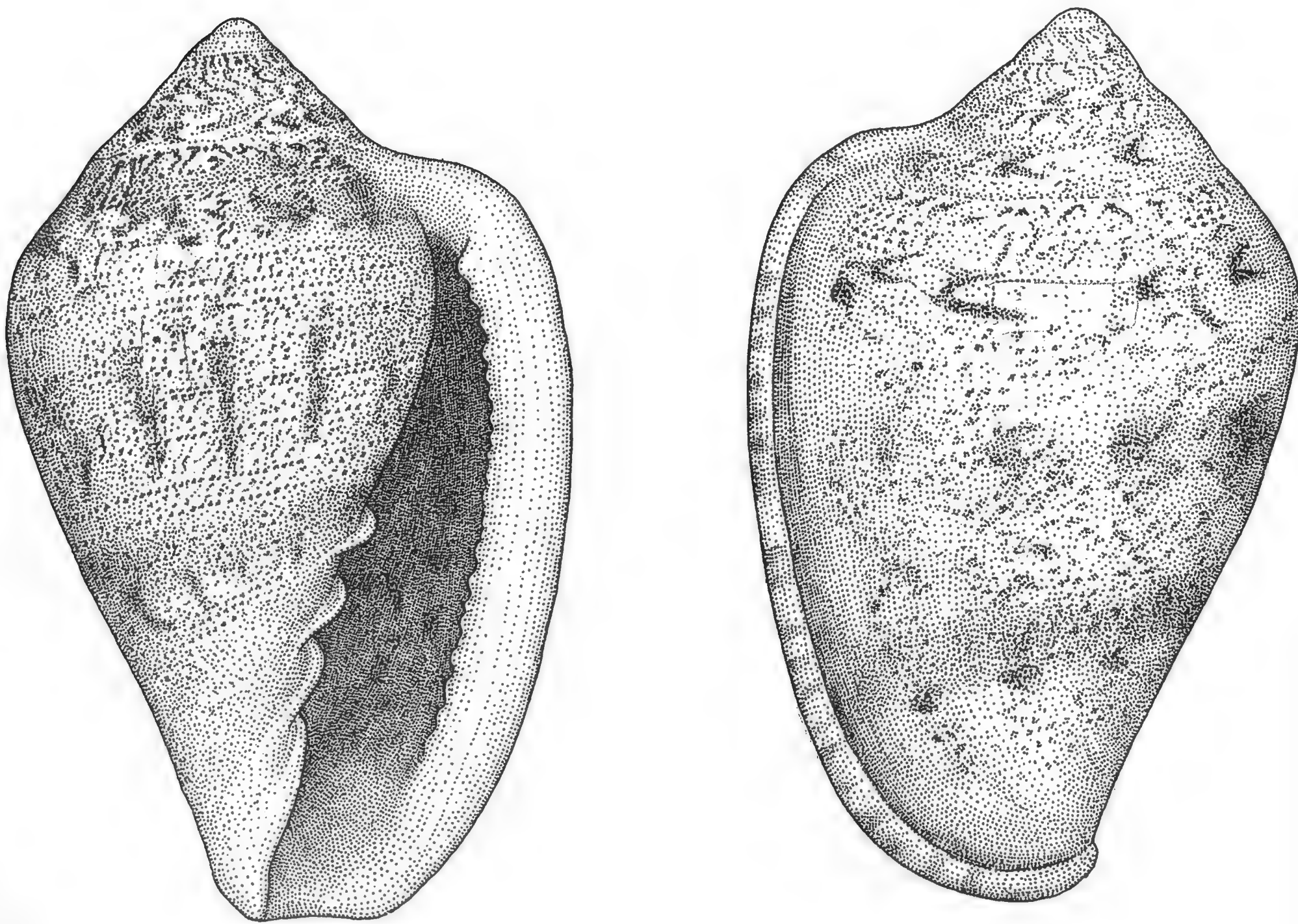


Fig. 13. *Marginella huberti* Clover: specimen from off Ilha de Luanda. Actual size 23.0 mm.

from the type locality (private collection of P. Clover). Paratype 2: BMNH n° 19728, Luanda, on beach.

*Type locality*: Baia dos Elefantes, Benguela, in 15 fathoms [27 m].

*Other material examined*: Off Pointe Noire, Congo, 104 m: 1 shell (MNHN). Off Farol das Lagostas, Luanda, numerous specimens (FF). Off Ilha de Luanda, 40–60 m: 3 specimens (1 juvenile) (MNHN) and 10 specimens (FF). Off Ponta de Noronha, Namibe, on silty sand and gravel 90 m: 1 specimen (FF). Angola, without other locality data, 2 shells (private collection of M. C. Macedo, Oeiras, Portugal).

*Description*: Shell 17 to 27 mm in length, 10 to 16 mm in greatest diameter (holotype  $18.8 \times 10.6$  mm), with low conical spire and indistinct suture. Outer lip thickened, strongly reflected outward with a sharp edge overhanging exterior of body whorl: inside with 15–25 small, irregular denticles, and one very strong isolated denticle near its posterior end. Aperture quite wide for the genus, narrowing anteriorly and posteriorly.

Two apical whorls pale brown; the remainder of the shell beige with tiny ash-grey dots arranged in spiral rows and looser wavy axial lines. Small dark blotches serially arranged along the suture, and a larger series of crescentic blotches just above the shoulder of the body whorl. Areas between shoulder and suture, and along a band on the anterior part of the body whorl, darker with blurred blotches; some darker blotches or flames also sometimes on the middle part of the body whorl. Outer lip with 15 to 25 dark grey streaks, often clustered by 2 or 3, mostly seen on the outermost, reflected part of the lip.

Head, siphon and foot uniformly covered with red-orange and pale yellow spots on a translucent, yellowish background.

*Habitat*: In shell gravel or mixed sediments around rocky areas, at 10 to 100 m.

*Remarks*: Two size classes may be recognized in the Angolan populations which we refer to *M. huberti*. The type material (holotype collected in 27 m) and specimens found in rather shallow water (10–20 m) off Farol das Lagostas at the entrance of Luanda harbour are about 18 mm high; the specimen stated by Clover (1972) to be found “dead on the beach at Luanda” originates from sand pumped just off Luanda harbour for refilling the Ilha sand-bar. Our specimens from deeper water (40–100 m) off Luanda are larger (21 to 27 mm high, fig. 13) but similar in shape and pattern.

*Marginella orstomi* Coomans, 1975 (type locality off Pointe Noire, Congo, in 200–250 m) differs in being narrower, with a lower apical angle and not so shouldered as *M. huberti*, but there are transitional specimens among our specimens from about 100 m depth; thus there may be a cline towards deeper water. The absence of denticulation on the type material of *M. orstomi* denotes subadult specimens.

### ***Marginella carquejai* n.sp. (Figs. 14, 20)**

*Type material*: Holotype (MNHN), 4 paratypes (BMNH, IIT, NM, UAN) and 10 paratypes (FF) from the type locality.

*Type locality*: Praia Amelia, 3–5 m.

*Other material examined*: Saco Mar, Namibe: 3 specimens (MNHN) and 35 specimens (FF). São Nicolau: 1 specimen (FF) and 1 shell (MNHN). Chapeu Armado: 1 specimen (FF). Bay of Lucira (Praia do Cesar), 10–20 m: 1 specimen (MNHN). Bay of Lucira (Bissonga), 20 m: 1 juvenile (MNHN).

*Description*: Shell 10 to 12 mm in length, 6 to 7 mm in greatest diameter (holotype  $11.4 \times 7.0$  mm), with low conical spire and indistinct suture. Outer lip strongly thickened and reflected outwards; inside with ca. 15 small, irregular denticles, and one stronger isolated denticle near posterior end. Aperture moderately wide, narrowing posteriorly.



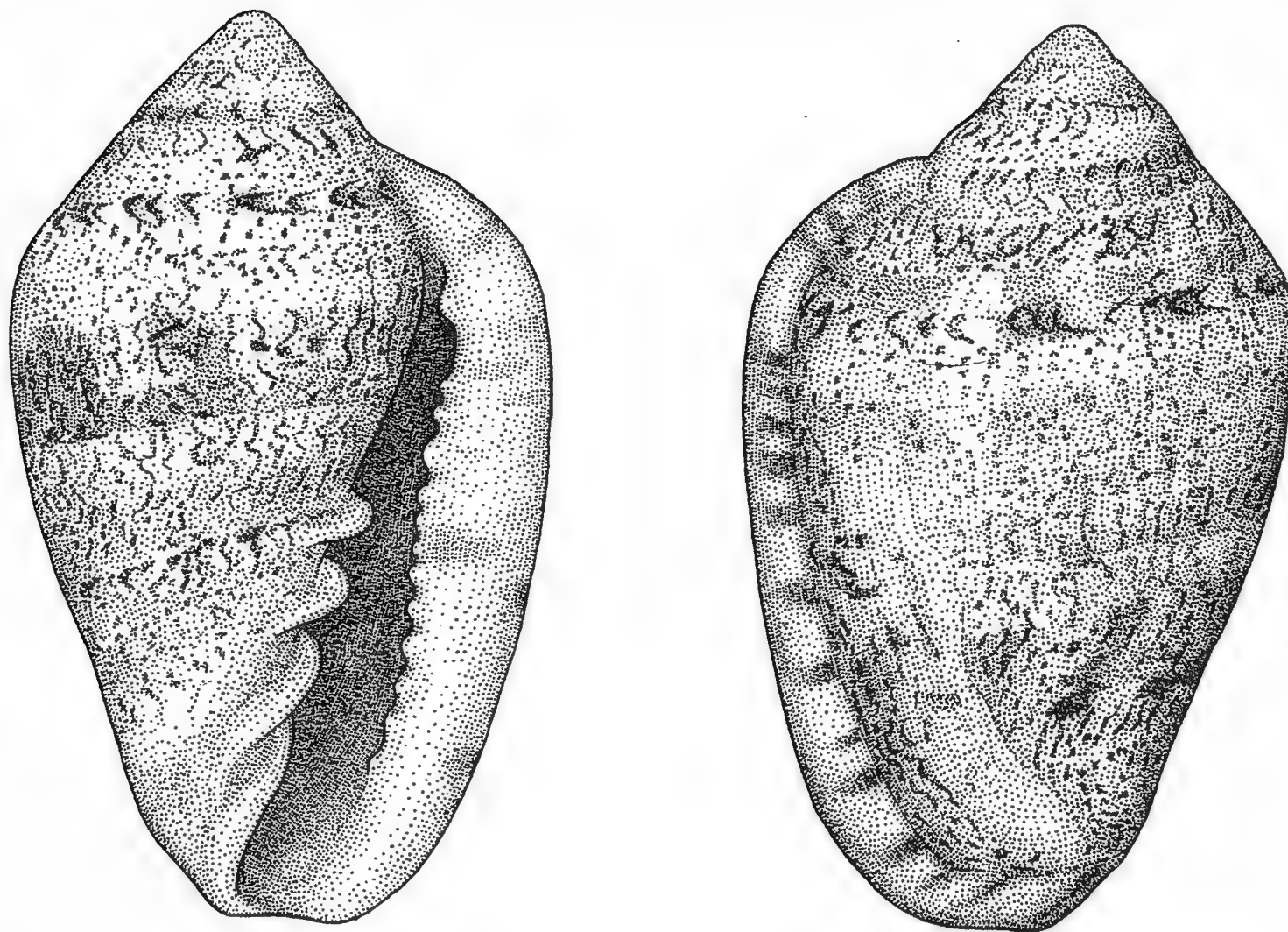


Fig. 14. *Marginella carquejai* n. sp.: holotype from Praia Amelia. Actual size 11.4 mm.

Apical whorl very pale, greenish with a comma-shaped apical dot; next whorl with two rows of dark grey dots; the remainder of the shell of the same pale background colour, with tiny ash-grey dots arranged in loose wavy axial lines, small black streaks serially arranged along the suture, and a larger series of crescentic blotches just above the shoulder of the body whorl. Areas between shoulder and suture, and along a band on the anterior part of the body whorl, darker with blurred blotches; a somewhat darker area also on the middle part of the body whorl. Outer lip with about 15 black streaks, often clustered in 2 or 3, mostly seen on the outermost, reflected part of the lip.

Head and foot entirely covered with small yellow and orange dots, evenly distributed on a colourless background. Tentacles translucent with somewhat larger orange and yellow dots. Siphon greyish, with scattered yellow and orange dots; a greyish stain also transversally on the propodium and longitudinally on the metapodium. Lobe of mantle, occasionally visible on the left side, colourless and opaque white margin.

*Habitat:* Among the algal mat and sediment-filled crevices of infralittoral rocky platforms, always subtidally at 2–10 m.

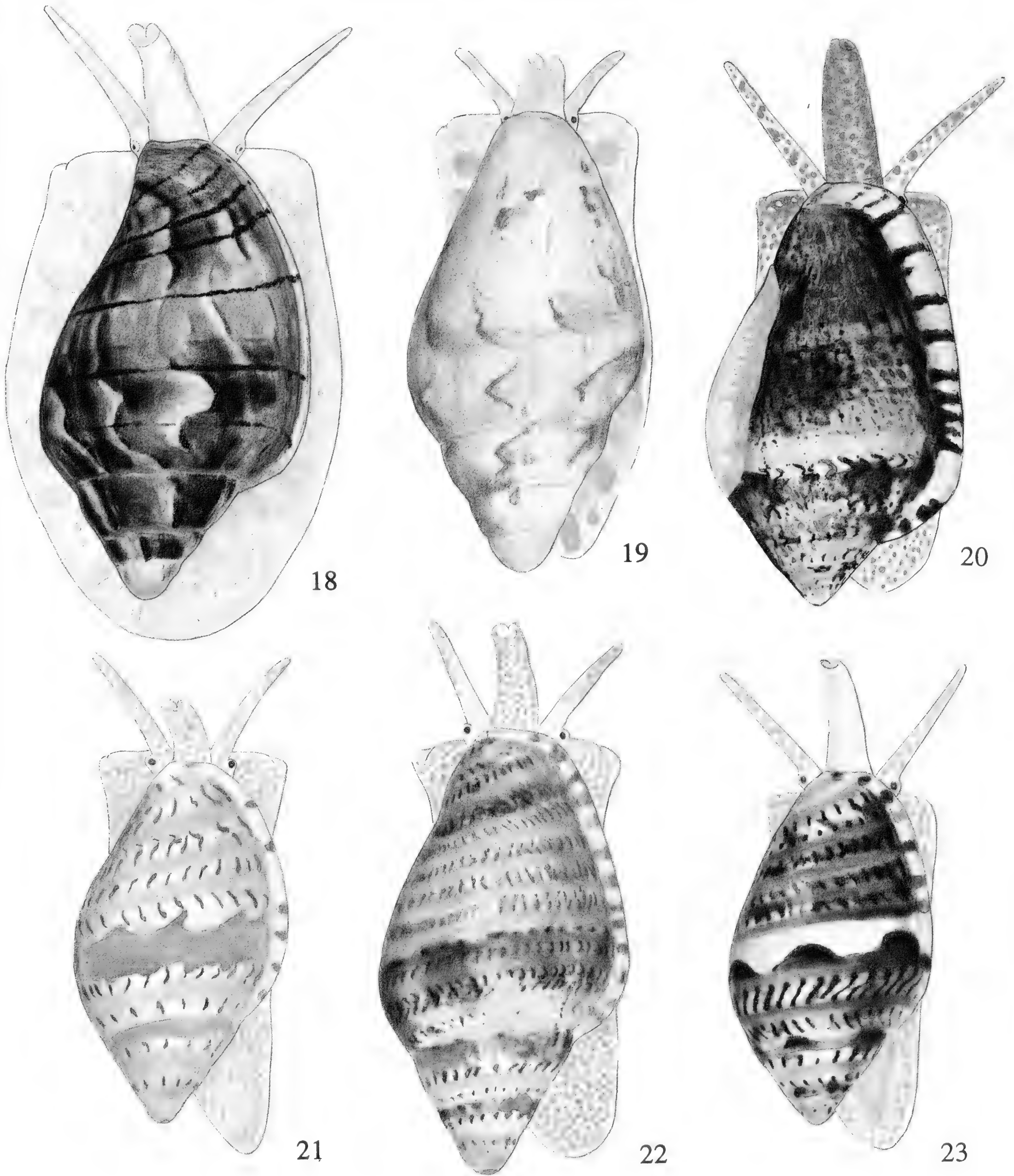
*Remarks:* This species has like *M. huberti* a larger denticle near the posterior termination of the inner lip. This character, unusual in *Marginella* is interpreted as a synapomorphy uniting the new species with *M. huberti*. *M. carquejai* is distinguished from *M. huberti* by its smaller size, darker shell and much thicker outer lip. It lives much shallower.

The species is dedicated to our friend Mario Albano dos Santos “Carqueja”, owner of a fishery in Namibe, who has been of invaluable assistance in our trips to Southern Angola.

*Note added in proof.*

We have seen a specimen of *M. carquejai* from the type locality, sent to MNHN by Mr. I. Felix-Alves (of Estoril, Portugal) labelled “*Marginella pariameliensis* Fernandes & Felix-Alves 1991, paratype”. Major malacological libraries, including that of MNHN (Paris), BMNH (London), Smithsonian Institution (Washington), Academy of Natural Sciences (Philadelphia) have to date no records of the publication, and we had considered *M. pariameliensis* as a manuscript name. In addition to a copy sent privately to the senior author in June 1994, there is now one record of the description known to us in a public library (Museum of





Figs. 18-23. Living specimens of Angolan *Marginella* (length of shells in brackets)

18. *Marginella lucani* Jousseaume: Cacuo (12.6 mm).

19. *Marginella fumigata* n. sp.: juvenile, off Palmeirinhas (15 mm).

20. *Marginella carquejai* n. sp.: Praia Amelia (11.4 mm).

21. *Marginella gemmula* Bavay: Luanda, Praia Etambar (6.6 mm).

22. *Marginella luculenta* n. sp.: off Ilha de Luanda (11.0 mm).

23. *Marginella undulans* n. sp.: Praia Amelia (6.4 mm).



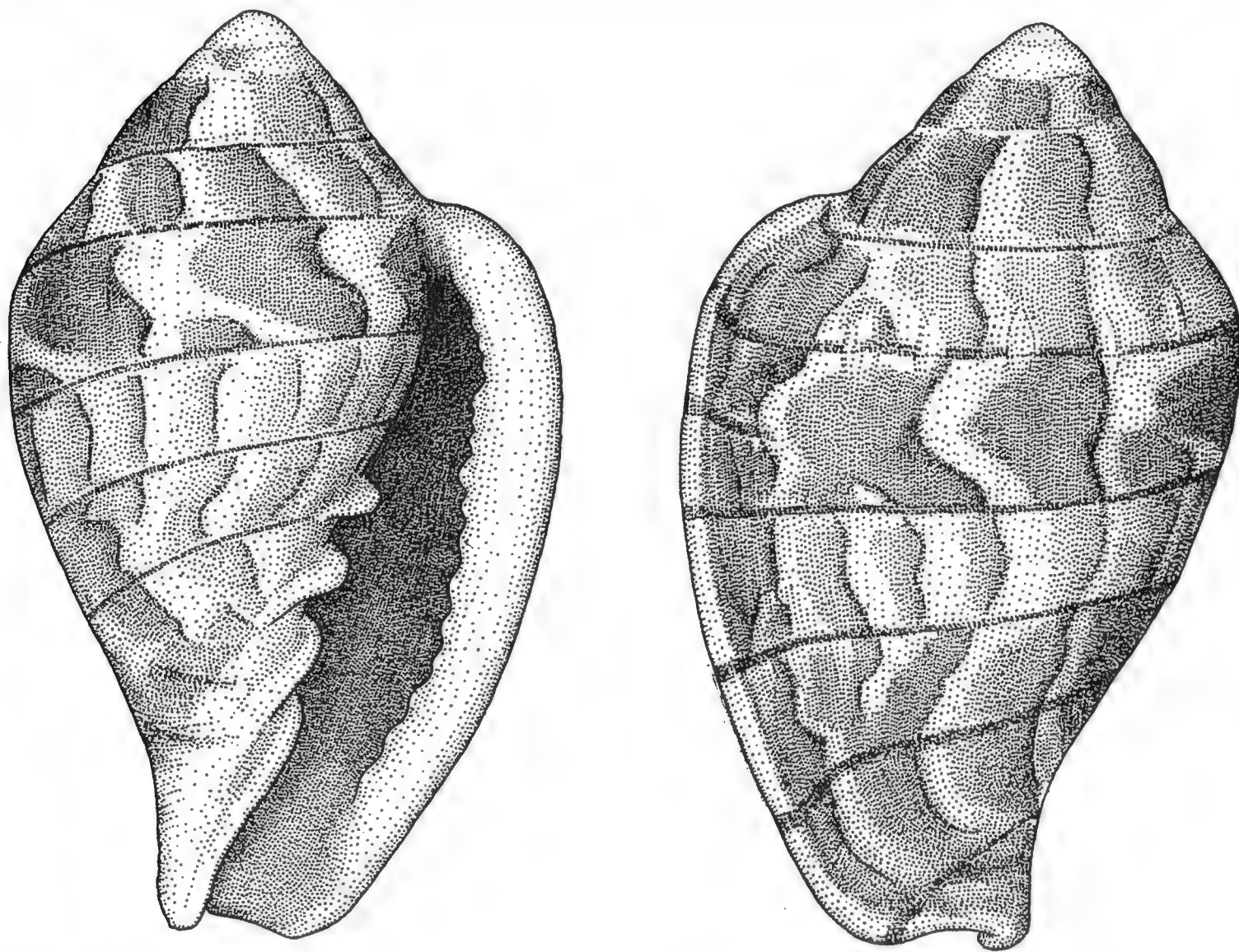


Fig. 15. *Marginella lucani* Jousseaume: specimen from Cacuo. Actual size 12.6 mm.

Comparative Zoology, Harvard), where three issues of *Boletim do Instituto Português de Malacologia*, dated July 30th, 1991 and August, 19th, 1991 were deposited in March 1992. We consider that, under provision of ICZN art. 9, this does not constitute a publication. The description of *M. pariameliensis* was printed using the present authors' material, data and names without our permission, and we proceed to describe *M. carquejai* as initially planned.

***Marginella lucani* Jousseaume, 1884 (Figs. 15, 18)**

*Marginella lucani* Jousseaume, 1884: 175–176, pl. 4 fig. 8

*Type material*: The figured syntype, here designated as lectotype (MNHN).

*Type locality*: Mayumba, Gabon.

*Other material examined*: Pambala: 1 shell (MNHN). Barra do Dande: 3 shells (MNHN). Cacuo 5–10 m: 2 adult specimens and 12 juveniles (MNHN). Ponta das Lagostas, 5–20 m: 1 specimen (MNHN). Palmeirinhas, near the mouth of Cuanza river: 2 specimens (FF).

*Description*: Shell 12 to 15 mm in length, 6.5 to 8.5 mm in greatest diameter (lectotype  $11.1 \times 6.5$  mm, apex eroded), with low conical spire and globular apex. Whorls slightly convex, with quite distinct suture. Body whorl somewhat shouldered, with sometimes some inconspicuous axial folds along the shoulder. Outer lip thickened and very strongly reflected outwards; inside with ca. 12–15 low, irregular denticles, becoming broader and fainter anteriorly. Aperture moderately wide, narrowing posteriorly. Siphonal margin quite protruding and bent upwards.

Two apical whorls whitish to tan. Remainder of the shell with broad greenish grey flames, grading to a dark, almost black edge on one side. Body whorl with in addition some 6–8 narrow black lines, one subsutural and the others evenly spaced in the whorl, continued on the outer margin of outer lip; design of flames often disrupted along these lines.

Foot broad and flat, of colourless background with large opaque yellowish white patches arranged radially on each side, and smaller flecks of the same colour on the propodium, on



the metapodium and between the larger patches. Head with tapering tentacles and tiny black eyes in a small bulge at the base of these. Tentacles with small yellowish white flecks. Siphon snow white, opaque.

*Habitat:* On the muddy bottoms of shallow bays with turbid waters, usually not far from the mouth of small coastal streams, at 5–10 m.

*Remarks:* This handsome and unmistakable species is restricted to the coastline from southern Gabon to Angola north of the Cuanza. It is loosely related to *M. eveleighi* Tomlin & Shackelford, 1913, also a soft-bottom dwelling species with yellow patches on the foot, and shell with axial folds and narrow black lines.

***Marginella fumigata* n. sp. (Figs. 16, 19)**

*Type material:* Holotype (MNHN), 2 paratypes (MNHN) and 5 paratypes (FF) from the type locality.

*Type locality:* Off Ilha de Luanda, 40–50 m.

*Other material examined:* Off mouth of the Congo, "Meteor" cruise M6-6, core 1000-1 C, 05°41,9'S, 11°42,6'E, 106 m: 2 shells (Paleontological Institute of University of Würzburg, Germany). Off Ambrizete, 45 m: 1 immature shell (MNHN). Off Palmeirinhas 80–120 m: 1 juvenile collected alive (MNHN), and 10 shells (FF). Off Mussulo, 100 m, 1 old shell (MNHN).

*Description:* Shell 13 to 16 mm in length, 7 to 8 mm in greatest diameter (holotype  $15.5 \times 7.9$  mm), with conical spire and globular apex. Whorls slightly convex, with quite distinct suture, the first two smooth, the next ones with faint axial ribs. Body whorl somewhat shouldered, with faint axial folds continued along the shoulder. Outer lip thickened and strongly reflected outwards; inside with about 12–15 low, irregular denticles, becoming smaller anteriorly; the space between the 2 most anterior denticles with a marked excavation. Aperture moderately wide, almost parallel-sided. Siphonal margin somewhat protruding and slightly bent upwards.

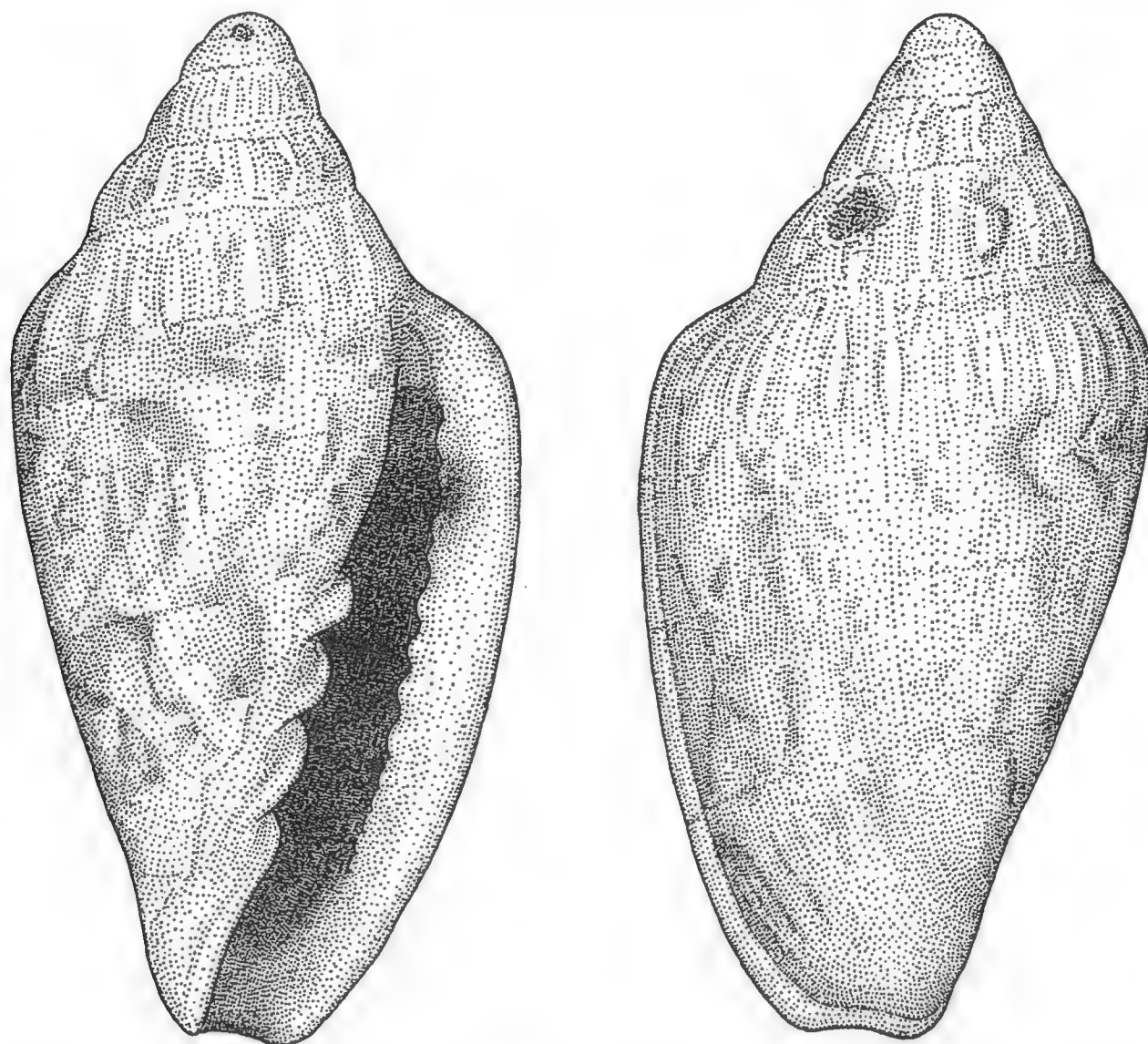


Fig. 16. *Marginella fumigata* n. sp.: holotype from off Ilha de Luanda. Actual size 15.5 mm.

Apical whorl greyish-tan. Remainder of the shell with poorly defined axial flames, sometimes disrupted in series of blotches; these flames more intense and projecting towards direction of coiling where crossing two spiral zones of the body whorl. Body whorl with in addition some 3–4 very faint spiral lines, one subsutural and the others evenly spaced on the whorl, continued on the outer margin of outer lip.

Foot with large opaque yellow patches arranged radially on sides and metapodium, and smaller flecks of the same colour on the propodium, more intense at the anterior angles of foot. Head with somewhat cylindrical tentacles with few yellow spots. Siphon cream white, opaque.

*Habitat*: On bottoms of rock and shell gravel at 40–100 m depth, rare.

*Remarks*: The peculiar depression near the anterior end of the inner lip looks accidental at first glance, suggesting the attempt by a predator to drill through the aperture, but it is seen consistently at the same spot on all six fully adult shells with thickened lip.

*Marginella fumigata* n.sp. resembles a species from Gabon figured by Bernard (1984) as *Marginella eveleighi* in general shape and size, and in having axial folds on the body whorl; it differs from it in lacking the very intense spiral lines and in being more slender and delicate in shape. The actual *M. eveleighi* Tomlin & Shackelford, 1913 is still another species, described from the island of São Tomé and possibly a junior synonym of *M. tyermani* Marrat, 1876 (see Gofas & Fernandes 1988).

*M. adansoni* Kiener, 1834 is superficially similar in having also axial folds on the body whorl. It differs in being larger, in lacking spiral lines and in a pattern of the head/foot dominated by small orange and white spots. It is restricted to the Senegal/Guinea area, and in our opinion specimens reported as *M. adansoni* from Galathea st. 61 (Victoria, Cameroun) by Knudsen (1956) are *Marginella bellii* Sowerby, 1846.

***Marginella marimba* n. sp. (Fig. 20)**

*Type material*: Holotype (MNHN) and 3 paratypes (FF) from the type locality.

*Type locality*: off Ilha de Luanda, 40–50 m.

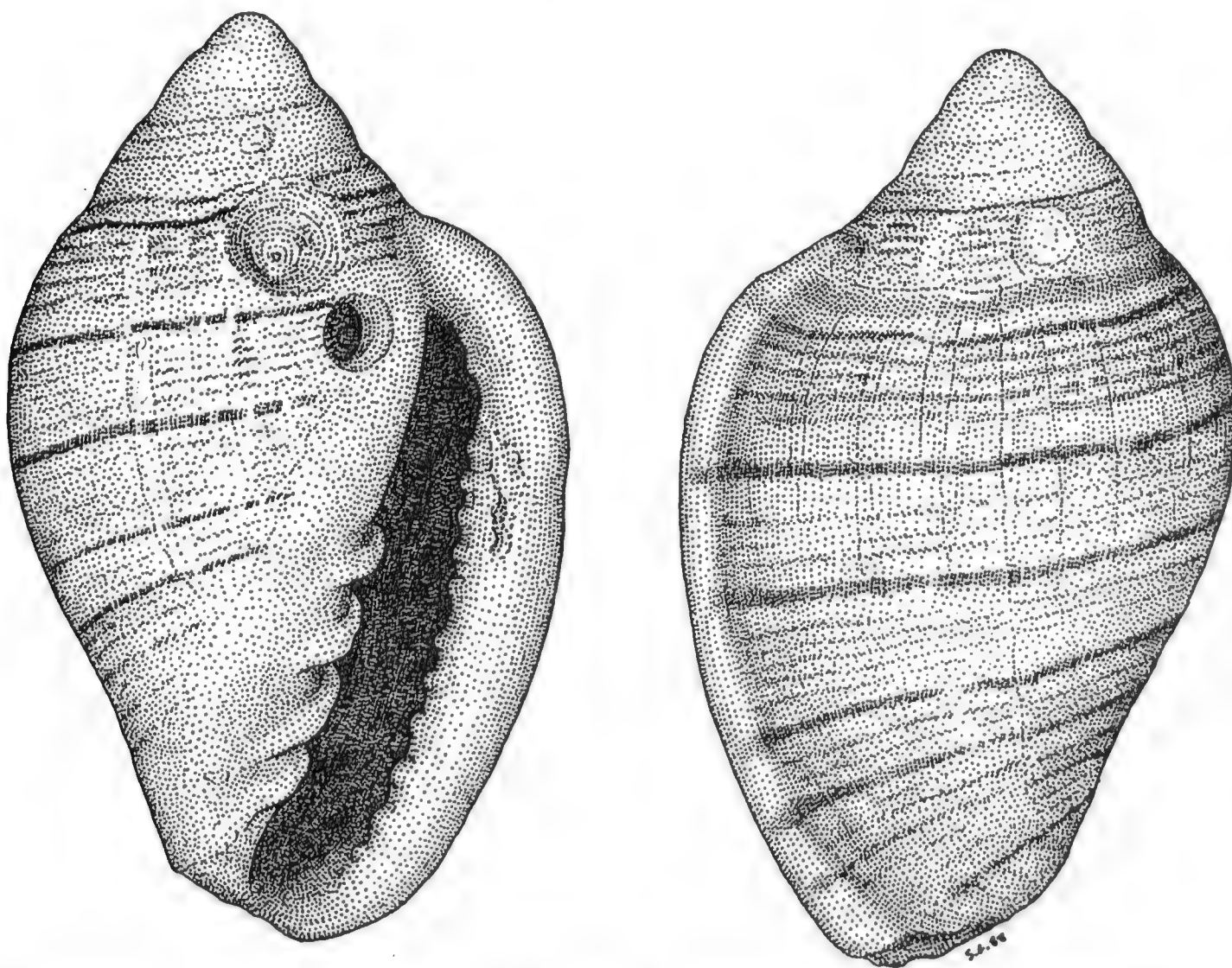


Fig. 17. *Marginella marimba* n. sp.: holotype from off Ilha de Luanda. Actual size 10.0 mm.

*Other material examined:* Gabon, from petroleum drilling site, private collection of C. Chevalier, Paris: 1 shell.

Shell (holotype)  $10.0 \times 6.0$  mm, with low conical spire and globular apex. Whorls hardly convex, with quite distinct suture. Body whorl well rounded, with some faint axial folds along its most swollen part. Outer lip strongly thickened; inside with ca. 12 definite denticles, one of them at the posterior end of the lip being somewhat apart from the others and separated from them by a depression. Aperture moderately wide, almost parallel sided.

Two apical whorls whitish to tan, remainder of the shell with a pattern of grey spiral lines, sometimes interrupted by paler axial zones. Body whorl with 6–7 of the spiral lines more intense and continuing over the outer lip.

Animal unknown.

*Habitat:* Unknown, probably among rock and gravel of the continental shelf, where the shell has been found.

*Remarks:* We have examined, apart from the type material, another specimen from Gabon which may be conspecific. It is slightly larger ( $12 \times 8$  mm), has more definite plication along the equatorial part of the body whorl, and lacks the paler small spiral lines between the major ones on the body whorl. The posterior denticle inside the outer lip is also offset.

*Marginella marimba* n. sp. recalls *M. musica* Hinds, 1844 and *M. diadochus* Adams & Reeve, 1848, by the pattern of spiral lines. *M. musica* lives in Mauritania and Senegal, has a more conical spire, and the inner lip smooth inside even on quite thickened adult specimens. The South African *M. diadochus* is larger (15–25 mm) and more slender, with a wider aperture and a thin, smooth inner lip.

The specimen illustrated by Knudsen (1956) from Atlantide St. 98 ( $5^{\circ}56'$  N,  $4^{\circ}26'$  E, off Ivory Coast), may be a juvenile of this species.

The name “marimba” given to this species is that of an Angolan musical instrument.

#### LIST OF ABBREVIATIONS

BMNH: British Museum (Natural History), London

FF: private collection of Francisco Fernandes

IIT: Instituto de Investigação Científica Tropical, Lisboa

MNHN: Muséum National d'Histoire Naturelle, Paris

NM: Natal Museum, Pietermaritzburg

UAN: Universidade Agostinho Neto, Luanda

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# *ANACHIS DONNAE* (GASTROPODA: COLUMBELLIDAE) A NEW COLUMBELLID SPECIES FROM MASIRAH ISLAND, OMAN\*

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(Accepted for publication, December 20th 1993)

*Abstract:* A new columbellid species, *Anachis donnae* n.sp., is described from Masirah Island, Sultanate of Oman. It differs from other Indian Ocean species in several ways, especially its distinctive colour pattern. It is compared with type material of *Columbella elata* Reeve, 1859, a taxon resembling it superficially.

*Key words:* Gastropoda, Columbellidae, *Anachis*, Oman, endemism.

## INTRODUCTION

The family Columbellidae is very extensive in numbers of described taxa. In 1902 the columbellid specialist S. I. Pace listed more than two thousand specific names (Pace 1902) and more taxa have been described since. Certainly several hundred scientifically acceptable species are now living in the world's warmer seas and many others are known as fossils. Also their shells display such diversity of form, sculpture and colour that no malacologist since Pace has studied the entire family in depth. There have been a few regional studies. For instance, some West Indian columbellid groups have been reviewed by Radwin (1977a, 1977b, 1978). Members of the *Strombina* group from the tropical American region have been revized by Jung (1989). A few columbellids from Papua New Guinea have been studied critically by Sleurs (1985, 1987). Our understanding of the relationships of the various proposed genera, however, is still rudimentary. The outline classification presented by Vaught (1989), for instance, must be considered only provisional.

Columbellids are widely distributed in warm waters and in some regions they form a significant part of the total molluscan fauna. They are well represented in the Gulf of Oman, as may be seen from the review by Melvill (1903). The recognition of two undescribed species from intertidal stations at Masirah Island and the coast of Dhofar by Smythe (1985) showed that further discoveries of the kind may be anticipated around a coastline noted for the high incidence of endemism among its molluscan species. Shells picked up at Masirah Island by Dr. Donald T. Bosch in the 1980s had been identified originally by us as *Columbella elata* Reeve, 1859. Comparison with type material of that species in the British Museum (Natural History), however, shows that they are quite distinct. As no similar species has been recognized by us in museum collections or in monographs of Sowerby (1844), Reeve (1859) and Tryon (1883) we believe the Masirah shells represent a species new to science.

\* Studies on the marine molluscan fauna of Oman, No. 10.

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## SYSTEMATIC DESCRIPTION

*Anachis donnae* n.sp. (Figs. 1–3)

*Description of the holotype:* In Zoological Museum Amsterdam (ZMA Moll. no. 3.94.011): Shell rather thick, moderately glossy, elongate-fusiform, slender with deep sutures: length 19.1 mm, width 7.1 mm. (Figs. 1–2). Protoconch of about 1.5 smooth whorls. Teleoconch of 7 slightly convex whorls with weak, slightly sigmoidal, axial ribs.

First teleoconch whorls with fine axial ribs with the axial sculpture gradually becoming more developed. Penultimate whorl with about 16 axial ribs and body whorl with about 11 axial ribs. The region before the thickened, outer lip is superficially smooth, but shows many very fine growth lines under magnification. Base of last whorl constricted and bearing about 7 weak spiral cords. Columella straight and parallel to axis; columellar callus well defined and smooth. Edge of slightly sigmoidal, outer lip thin with slight indications of denticles on inner side [holotype not completely full grown].

*Colour:* Initial part of protoconch milky-white, developing a rather broad white band. Remaining part brown. First 3 post-nuclear whorls reddish brown, with a few subsutural white spots. Subsequently, a network enclosing oval white spots develops and becomes gradually more prominent. Reddish brown blotches tend to form a spiral band on later whorls (2 bands on last whorl). Aperture whitish.

*Type locality:* Sultanate of Oman, Masirah Island, west coast near Sur, 1989, leg. D. T. & E. Bosch.

*Paratypes:* All paratypes are from the type locality and all were collected intertidally or on the beach. Dr. D. T. Bosch and E. Bosch collected a total of 15 shells between 1982 and 1989; H. Henseler collected a single shell and S. P. Dance collected 2 recently dead shells on 17 February 1989. Six paratypes are deposited in the ZMA with no. Moll. 3.94.012–013. The remaining paratypes will be given to the Natural History Museum of Oman (Muscat), the Natural History Museum (London), the National Museum of Wales (Cardiff), the



Figs. 1–3. *Anachis donnae* n.sp., Sur Masirah, Sultanate of Oman. Fig. 1–2. holotype, length 19.1 mm. Fig. 3. paratype, length 19.7 mm.

Fig. 4. *Columbella elata* Reeve, 1859, syntype 16.2 mm (BMNH 1993031).

Manchester Museum (Manchester) and the private collections of H. Henseler, S. P. Dance and H. Dekker.

*Variation of paratypes:* In most respects the paratypes show little variation in form. The colour pattern is constant although the white areas within the netted lines are larger on some shells than on others. Only in full grown specimens do 4–5 rather strong denticles occur on the inner surface of the outer lip. Some specimens still have the very thin, translucent brown periostracum. The smallest paratype has a length of 17.2 mm whereas the largest one measures 21.4 mm. The average length is 19.5 mm ( $n=18$ ).

*Etymology:* The new species is named after Donna Apcar, granddaughter of Donald and Eloise Bosch.

*Remarks:* There was a possibility that the new species was merely a form of the little-known *Columbella elata* Reeve, 1859. A syntype of that species from the Hugh Cuming collection at the Natural History Museum (London) is more slender, has a straighter aperture and more prominent axial ribs. Also the colour pattern differs in having less numerous, blackish dots on the whorls (Fig. 4). Provisionally we have placed the new species in the genus *Anachis*. Future research, especially of anatomical features, may show that it ought to be placed in genera like *Mitrella* or even *Strombina*.

#### ACKNOWLEDGEMENTS

We are indebted to Dr. D. T. Bosch for arranging our visits to the Sultanate of Oman to collect and study molluscs, and to him and to Eloise, his wife, for help and hospitality while there. Christine and Valter Hagström, Una Dance and Henk Dekker were constant and helpful companions during our collecting activities. Thanks are due to the staff of the BERS station on Masirah Island for accommodation and meals. We wish to show our appreciation to KLM Oman (Mr. J. W. Creutzberg and J. Simpson) for kindly arranging a courtesy ticket from Amsterdam to Seeb. Similarly, we gratefully acknowledge the award of a grant by the Percy Sladen Trust Fund (administered by the Linnean Society of London) which helped defray the cost of travel expenses. We are also grateful to Ms K. Way for kindly arranging the loan of type material housed in the Natural History Museum (London). The photographs were made by L. A. van der Laan (ZMA, University of Amsterdam).

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# A NOTE ON *PERISTERNIA ZEALANDICA* (KOBELT IN KÜSTER & KOBELT, 1876) (GASTROPODA: FASCIOLARIIDAE)

D. G. HERBERT<sup>1</sup>

(Accepted for publication, May 21st 1994)

**Abstract:** Authorship of the name *Turbinella zealandica* is credited to Kobelt in Küster & Kobelt (1876) and a lectotype for the taxon designated from the type material. Following Tapparone-Canefri (1879) the original locality data are rejected and the type locality emended to Mauritius. Additional material with accurate locality data is now available from the Mascarene Islands. Tapparone-Canefri's replacement name, *Peristernia kobeltiana*, is an unjustified substitution.

**Key words:** Fasciolariidae, *Peristernia zealandica*, Mascarene Islands, lectotype, type locality.

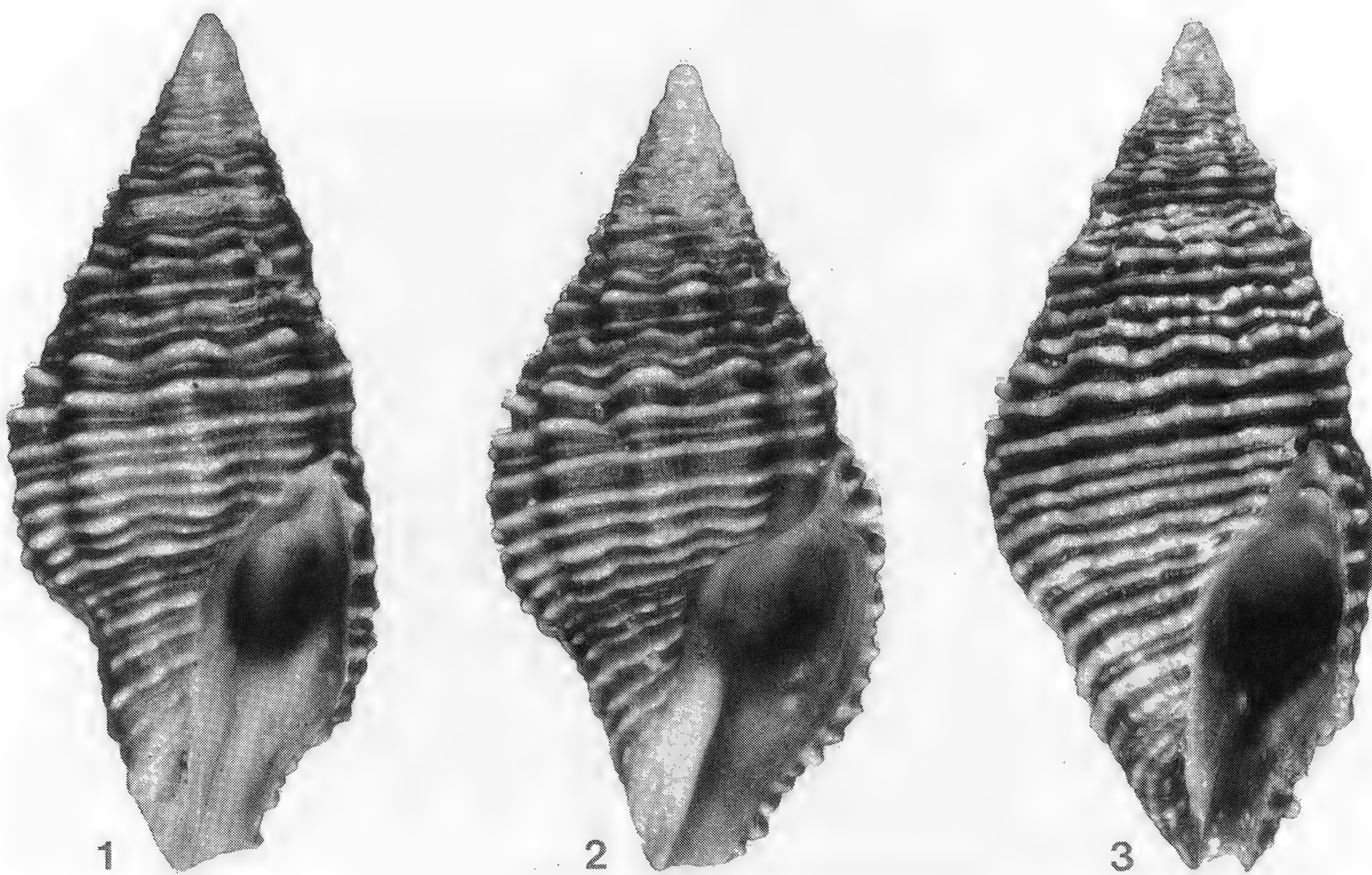
In his treatment of the genera *Turbinella* and *Fasciolaria* for the second edition of the *Conchylien Cabinet*, Kobelt (in Küster & Kobelt 1876) discussed and figured a species under the name *Turbinella zealandica*, which he tentatively attributed to A. Adams, although he could not himself trace the original publication of the description. Trew (1992) likewise listed no fasciolariid taxa bearing this specific name in her publication on the molluscan names proposed by the Adams brothers. It must therefore be concluded that *zealandica* A. Adams was merely a manuscript name and consequently has no nomenclatural status. The first published description of the species was thus that which appeared in the *Conchylien Cabinet* in 1876. As this was drawn up by Kobelt, based on the Paetel collection specimens available to him (with nothing contributed by Adams), the authorship of the name must be credited to Kobelt (in Küster & Kobelt, 1876).

There are currently two lots (totalling 3 specimens) from the Paetel collection identified as *Turbinella zealandica* in the ZMHB, both reportedly originating in New Zealand, the given type locality. One of these contains two specimens (Figs. 1, 2) which correspond well with Kobelt's description; the shell in the second lot, though almost certainly congeneric, is quite clearly a different species. The dimensions given by Kobelt fit almost exactly those of the more slender of the two shells in the correctly identified lot and it is quite possible that the original figure too was drawn from this shell. These two specimens can, with reasonable certainty, be regarded as syntypes and I here designate the narrower shell as lectotype (Fig. 1).

Tapparone-Canefri (1879) subsequently identified material from Mauritius (obtained *per* Robillard) as "*Latirus zeelandica* [*sic*] A. Adams", and, in a somewhat sweeping statement ("Or, il n'est pas probable qu'une coquille marine côtière de Maurice se trouve aussi à la Nouvelle Zélande . . ."), claimed that it was not possible for the original material to have originated from New Zealand. Believing this to be the case, he then proposed a new name for the species, *Peristernia kobeltiana*, rejecting the original one on the grounds that it reflected erroneous provenance. In terms of the ICZN Code, however, validly proposed scientific names cannot be rejected on the grounds of inappropriateness and *zealandica* must remain the valid name for the species.

Tapparone-Canefri's observation and nomenclatural proposal were not mentioned by

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Figs. 1–3. *Peristernia zealandica* (Kobelt in Küster & Kobelt, 1876). 1, lectotype of *Turbinella zealandica* Kobelt in Küster & Kobelt, 1876, (ZMHB), 23.5 mm × 10.5 mm; 2, paralectotype of the same (ZMHB), 25.8 mm × 12.9 mm; 3, Natal Museum specimen from Mauritius, at 15–25 m (NMSA L30), 26.5 mm × 12.3 mm.

Tryon (1881), who accepted the original locality data and incorrectly treated the name as a synonym of *Peristernia despecta* A. Adams, 1855. The type of the latter has been illustrated by Kaicher (1986) and is clearly distinct. Melvill (1891), in his catalogue of *Latirus* and *Peristernia*, listed the species under *Peristernia kobeltiana*, and also mentioned it in the remarks following his description of *P. hilaris*, but added no new information. The species does not seem to have been discussed in the literature since then, although some correctly identified shells were figured by Kaicher (1986). There has been no confirmation as to whether or not Tapparone-Canefri was justified to refer his Mauritian material to Kobelt's species and I have been unable to ascertain whether his specimens are still present in the Museo Civico di Storia Naturale di Genova, Italy, which reportedly houses the Tapparone-Canefri collection (or part thereof) (Dance 1986). There have been no further reports of the species from Mauritius or the other islands comprising the Mascarene Archipelago.

On a recent Natal Museum expedition to this island group, I collected, off Mauritius, a fresh specimen of a *Peristernia* species which, upon subsequent investigation, appeared comparable with Tapparone-Canefri's figure of *kobeltiana*. This specimen (Fig. 3) I later took to the ZMHB for comparison with the original Paetel specimens of *Turbinella zealandica*, in the hope of finding such still extant. As indicated above this material was located and the Mauritian specimen proved to be very similar and is doubtlessly conspecific (compare Figs. 1–3). Tapparone-Canefri's assertion that his Mauritian material was referable to this species is thus supported. Subsequently another specimen, a juvenile, has been identified amongst Réunion Island material sent to the Natal Museum by J. Drivas. The possibility that the species occurs in both the tropical western Indian Ocean and in New Zealand is indeed



remote (cf. Tapparone-Canefri 1879). The species has not been recorded in New Zealand since the original description and one must concur with Tapparone-Canefri in rejecting the original locality data. I take this opportunity to emend the type locality to the island of Mauritius.

The taxon is evidently a rare one and very little material is available. It is impossible at present to make any meaningful observations on the distribution of the species. The only material that I have seen personally has come from the Mascarene Islands, but a search through the fasciolariid material in the collections of other museums may bring to light additional specimens, perhaps from more widely spread localities. A number of other *Peristernia* species have been described from Mauritius, most notably by Melvill (1891, 1911); some, such as *P. jeaniae* (Melvill, 1911), show considerable similarity with the present species and merit careful comparison. The type material of *P. jeaniae* (NMW 1955.158.347–8) differs from *P. zealandica*, in having more strongly convex whorls, more numerous and more close-set spiral ridges, and more prominent, more strongly shouldered axial ribs (Fig. 4). However, it is not possible to evaluate these differences since with so little material

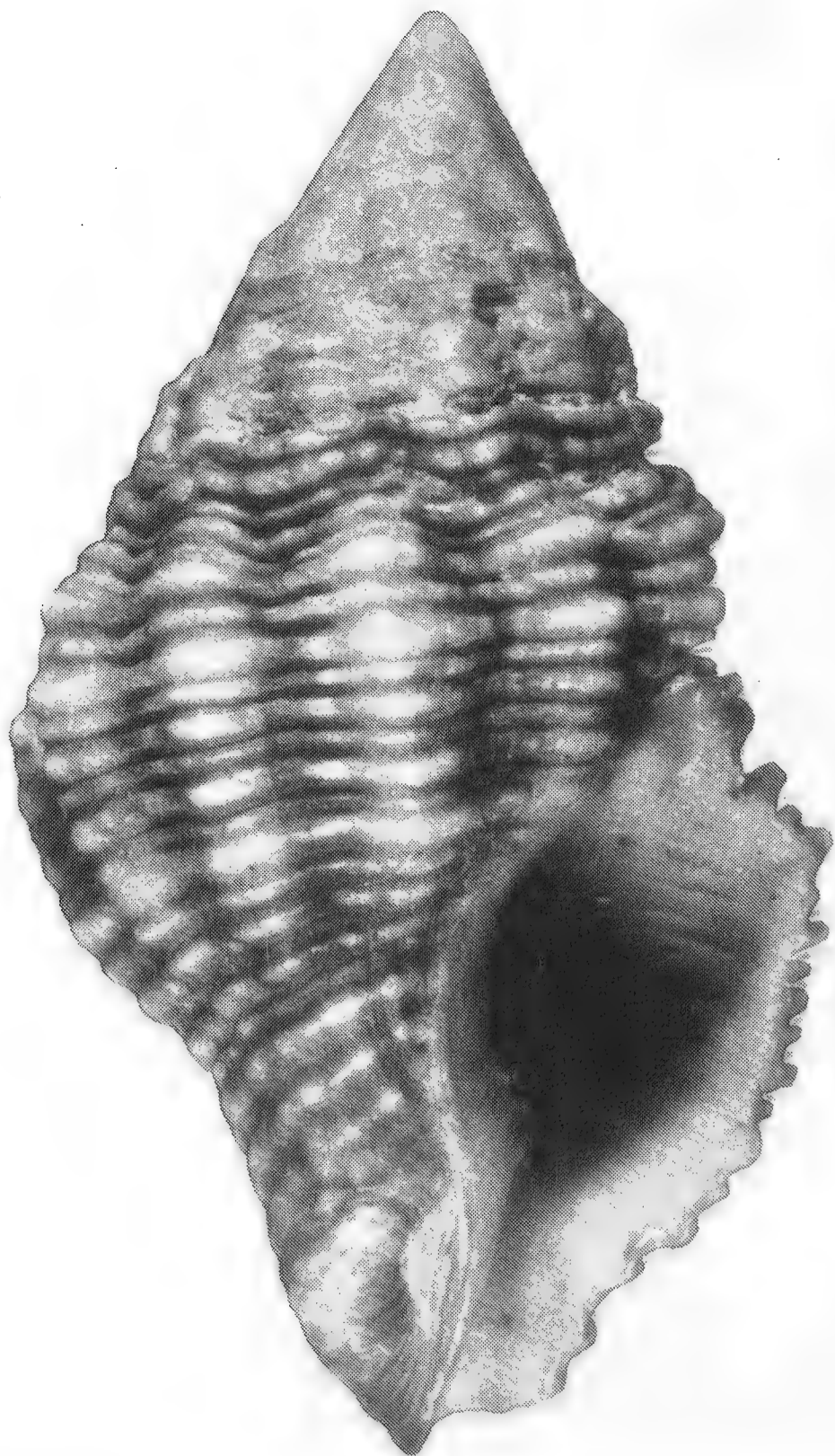


Fig. 4. *Latirus* (*Peristernia*) *jeaniae* Melvill, 1911, one of five syntypes (NMW, 1955.158.347–348), 22.4 mm × 12.8 mm.



available no assessment of intraspecific variability can be made. I could find no specimens of *P. zealandica* in the MNHN, and could not trace the BMNH specimen cited by Melvill (1891:396 as *P. kobeltiana*). The portion of Viader's Mauritian collection recently acquired by the AMS has no fasciolariid material under either *zealandica* or *kobeltiana* (Lösch, *in lit.*).

Following Tapparone-Canefri (1879) and Melvill (1891), I have referred the species to *Peristernia*. On conchological grounds this is strongly supported, but confirmation based on examination of the radula is required (cf. Thiele 1929).

#### UP-DATED SYNONYMY

##### *Peristernia zealandica* (Kobelt in Küster & Kobelt, 1876)

*Turbinella zealandica* (?A. Ad.) Kobelt in Küster & Kobelt, 1876:108, pl. 25, figs 14, 15. Type locality: given as New Zealand, but here emended to Mauritius.

*Plicatella zealandica*; Kobelt, 1876:24.

*Peristernia kobeltiana* Tapparone-Canefri, 1879:320 (*nom. nov. pro T. zealandica* Kobelt); *idem*, 1881:72, pl. 3, figs 17, 18; Melvill, 1891:396, 407; Viader, 1937:24.

*Peristernia zealandica* (attributed to A. Adams); Tryon, 1881:85, pl. 66, fig. 98; Kaicher, 1986: card no 4657.

#### LOCALITY DATA

S.W. Mauritius: off Pointe des Pêcheurs, Le Morne Peninsula, 15–25 m, D. Herbert (NMSA L30).

Réunion: off Boucan Canot, 55 m, on coral, J. Drivas (NMSA L613).

#### ABBREVIATIONS

- AMS – Australian Museum, Sydney
- BMNH – The Natural History Museum, London.
- MNHN – Muséum National d'Histoire Naturelle, Paris.
- NMSA – Natal Museum, Pietermaritzburg, South Africa.
- NMW – National Museum of Wales, Cardiff.
- ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin.

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# HERBERT: A NOTE ON *PERISTERIA ZEALANDICA*

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# A NEW CORALLIOPHILID-LIKE MURICID (GASTROPODA, MURICIDAE) FROM THE CORAL SEA

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(Accepted for publication, May 21st, 1994)

*Abstract:* *Xastilia kosugei* n.gen., n.sp. is described from depths of 250–300 m on Capel Bank, a guyot in the Coral Sea, SW Pacific. The shell resembles those of the Coralliophilidae, but its radula is characteristic of the muricid subfamily Muricopsinae.

*Key words:* Muricidae, Coralliophilidae, convergence, endemism, Coral Sea.

## INTRODUCTION

In the central part of the Coral Sea, the Lord Howe seamount chain stretches over a thousand kilometres between Lord Howe and the Chesterfield Islands. At 25°S, Capel Bank is the largest and southernmost of four guyots explored for benthos in 1984 and 1986. It has a plateau area of ca. 3,000 sq. km, and culminates at a depth of 58 m, with a second, deeper terrace at 260–320 m.

The deep-water mollusc fauna of the islands and guyots of the central Coral Sea presents a number of species known only from these geographically isolated structures. *Perotrochus deforgesi* Métivier, 1990, *Cassis abbotti* Bouchet, 1987, *Pterynotus richeri* Houart, 1987, *Amalda coriolis* Kilburn & Bouchet, 1988, *Lyria exorata* Bouchet & Poppe, 1988 and *Conus luciae* Moolenbeek, 1986 are the most spectacular gastropods of this remarkable assemblage.

Here we describe another new member of this fauna, based on 5 specimens dredged on the deeper terrace of Capel Bank.

## SYSTEMATIC DESCRIPTION

Family MURICIDAE Rafinesque, 1815

Subfamily MURICOPSINAE Radwin & D'Attilio, 1971

Genus *Xastilia* n.gen.

Type species: *Xastilia kosugei* n.sp.

*Diagnosis:* Shell with low, flat axial varices, bearing two rows of long, narrowly open spines on last teleoconch whorl. Siphonal canal narrow, long, narrowly open. Aperture with strongly erect, flaring columellar lip. Operculum with apical nucleus. Rachidian tooth of the radula with short, projecting central cusp, 2 short lateral cusps, and 2 smaller lateral denticles.

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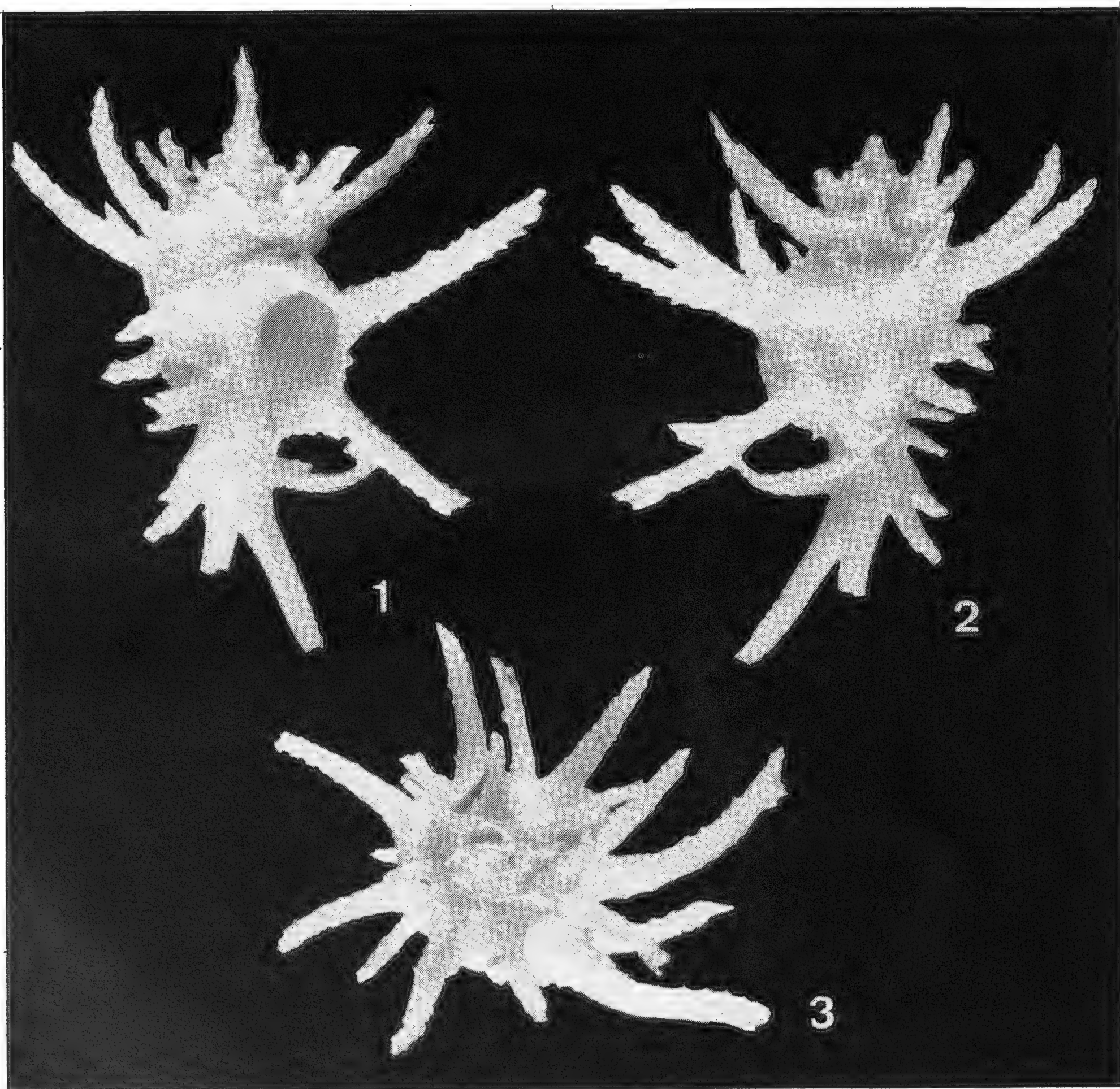
<sup>2</sup> 3400 Landen (Ezemaal), Belgium, Research Associate, Institut Royal des Sciences Naturelles de Belgique.

*Xastilia kosugei* n.sp.

Figs. 1-7

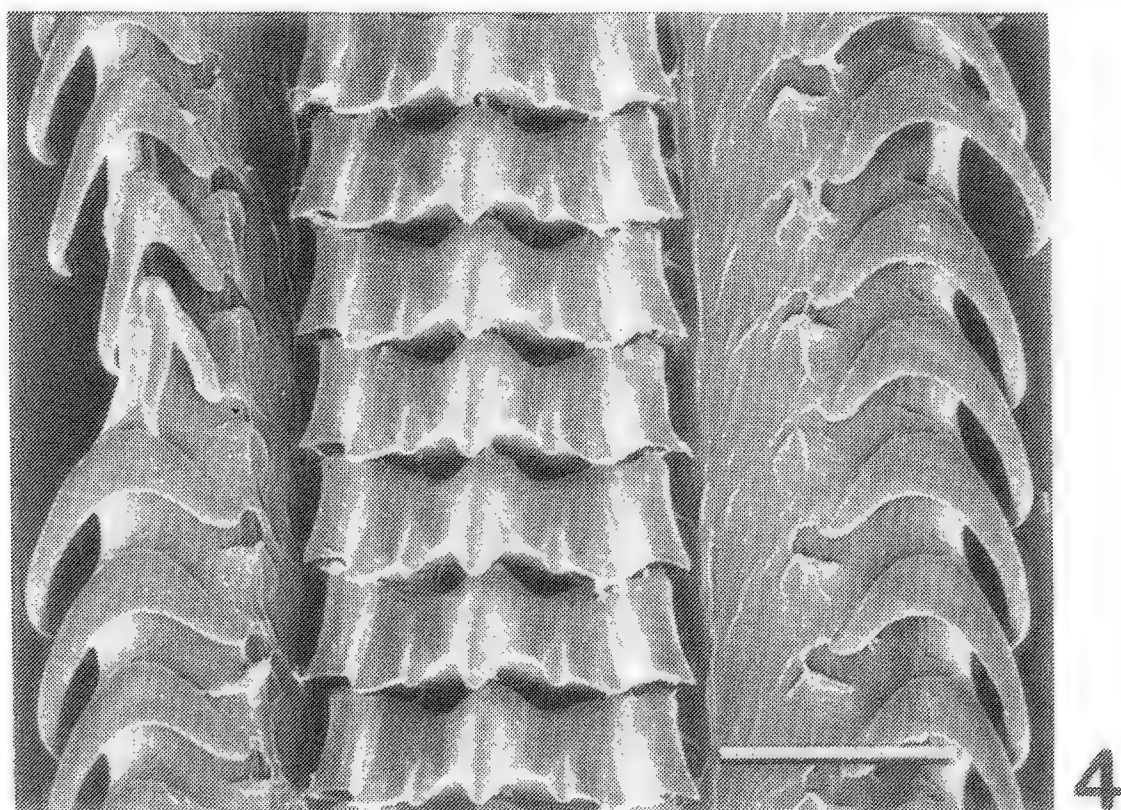
*Type material:* MUSORSTOM 5: stn CP 276, 24°49' S – 159°41' E, Capel Bank, Coral Sea, 258–269 m, 9 October 1986, R. V. *Coriolis* (holotype and 2 paratypes MNHN, 1 paratype coll. R. Houart); stn DW 257, 25°20' S – 159°51' E, 300 m, 7 October 1986 (paratype MNHN).

*Description:* Shell large, from 22.1 to 30.5 mm in length, roughly fusiform, fragile, consisting of 1.75 protoconch whorls and up to 5 weakly shouldered, spiny teleoconch whorls, with weakly impressed suture. Protoconch whorls rounded, smooth; terminal varix weakly erect and curved. Axial sculpture consisting of low varices: 7 or 8 on first teleoconch whorl, 8 on second, 7 from third to last teleoconch whorls. Varices very low, almost flat on penultimate and last teleoconch whorls, bearing long, squamous, slender, narrowly open spines: one on third and fourth teleoconch whorls, two on last whorl. First, second and third teleoconch whorls with higher varices, almost spineless on first and second whorls, with short spines on

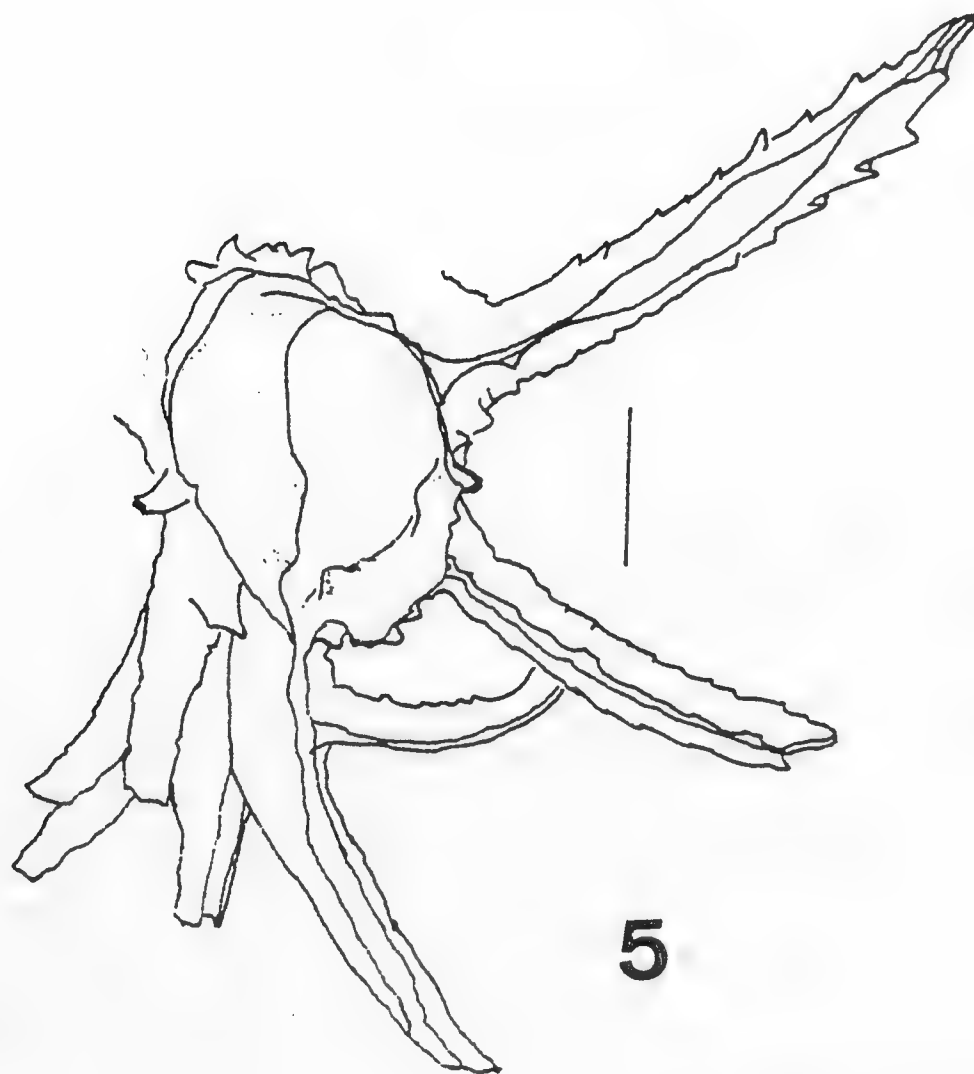


1-3. *Xastilia kosugei* n.sp., holotype MNHN, height 30.5 mm.





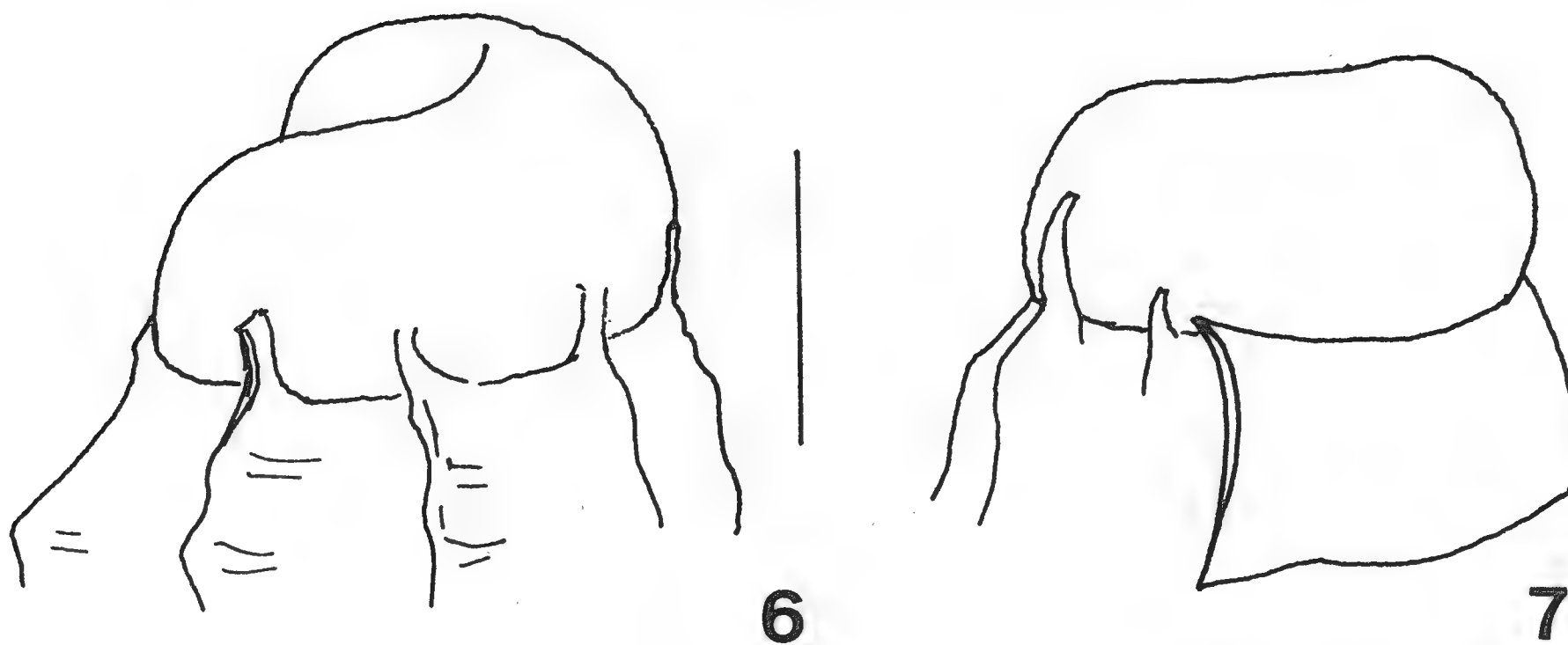
4. Radula of *X. kosugei* n.sp. (scale bar 50  $\mu$ m).



5. Apertural view of *X. kosugei* n.sp. (holotype) (scale bar: 4 mm).

third whorl. Spiral sculpture consisting of 3 rounded cords on first and second teleoconch whorls; third whorl with 2 rounded cords and 1 or 2 threads between them; fourth whorl with 1 peripheral cord, numerous striae, and squamous lirae; last teleoconch whorl with 2 low cords that interconnect the spines, numerous striae and squamous lirae. Aperture roundly-ovate; columellar lip flaring, strongly erect, smooth; outer lip erect, with 2 or 3 low denticles abapically; anal notch broad, shallow. Siphonal canal long, open, abaxially curved, bearing a single, long, acute open spine adaperturally. Remnants of previous siphonal canals obvious, each with single, long open spine. Shell white. Operculum ovate with terminal nucleus. Radula muricopsine, with sickle-shaped lateral tooth on each side of a rachidian tooth bearing a short, projecting central cusp, 2 short lateral cusps and 2 smaller lateral denticles.





6–7. Protoconch of *X. kosugei* n.sp. (paratype MNHN). Scale bar 0.5 mm.

Dimensions of the holotype: height 30.5 mm, breadth 30 mm (inclusive of spines); aperture diameter 5.3 mm.

*Etymology*: The generic name *Xastilia* is an anagram of *Latiaxis* Swainson, 1840, the emblematic genus of the family Coralliophilidae. The specific name honours Dr Sadao Kosuge (Tokyo), in recognition of his work on the family.

#### DISCUSSION

There are no conchologically similar genera in the family Muricidae. Amongst the coralliophilids, *Xastilia* resembles *Echinolatiaxis* Kosuge, 1979, which also has two rows of long spines, but *Xastilia* has the typical aperture of some species of Muricidae, with a flaring columellar lip, bearing low, abapical nodes, and an erect outer lip with 2 or 3 low nodes within (Fig. 5). The operculum of *Xastilia kosugei* n.sp. also has a typical muricopsine basal (apical) nucleus, compared to the lateral nucleus of coralliophilid opercula.

Two characters need to be discussed in conjunction with the familial position of *Xastilia*, namely the protoconch and radula.

The protoconch of *Xastilia kosugei* is paucispiral and smooth (Figs 6–7), and indicates non-planktotrophic larval development. This is a character that could be derived from any of the multispiral (planktotrophic) types found in the Muricoidea. Smooth, paucispiral protoconchs are largely convergent over the different subfamilies of Muricidae, however such protoconchs have already been recorded in the literature in the Coralliophilidae (D'Attilio 1972). We also have observed similar smooth, paucispiral protoconchs in both shallow and deep-water Coralliophilidae for New Caledonia. The protoconch of *Xastilia kosugei* is therefore not informative at family level, and may not even be a generic characteristic. Species of *Xastilia* with planktotrophic development, and thus multispiral protoconch, may be discovered in the future.

Presence/absence of a radula is the diagnostic character traditionally separating Muricidae from Coralliophilidae, and it is generally accepted that Coralliophilidae are specialized muricids that have lost the radula. Anatomical differences between Muricidae and Coralliophilidae have not been spelled out, but in *Coralliophila abbreviata* dorsal glandular folds to the oesophagus and accessory salivary glands are lacking, and the salivary ducts are separated from the oesophageal wall (Ward 1965). The absence of accessory

salivary glands is certainly connected with the loss of radula. Too few muricids and coralliophilids are known anatomically to say if the other two characters hold throughout the family. While some authors (e.g. Radwin & D'Attilio 1976, D'Attilio 1978, Boss 1982, Kosuge & Suzuki 1985) rank the Coralliophilidae as a family, others (e.g. Ponder & Warén 1988, Rosenberg 1992) rank it only as a subfamily within Muricidae. It is therefore open to question whether one should view *Xastilia* (a) as a primitive coralliophilid that has retained a radula, or (b) as a muricid with a shell convergent to that of the coralliophilids. It is beyond the scope of the present paper to reevaluate the suprageneric classification of the Muricoidea. The traditional, radula-based, separation of Muricidae and Coralliophilidae, as well as the construction of the columellar lip, place this genus in the Muricidae, and the morphology of the rachidian tooth further indicates a placement in the subfamily Muricopsinae.

However, we want to draw attention to the unique blend of muricid and coralliophilid characters within *Xastilia*, and suggest that it needs further attention in the study of the muricoid radiation.

#### ACKNOWLEDGEMENTS

We are grateful to R. Duchamps (Brussels, Belgium) who loaned specimens for this study. Thanks also to A. Warén (Swedish Museum of Natural History, Stockholm) for SEM work, V. Heros (Muséum National d'Histoire Naturelle, Paris) for her collaboration, C. M. Hertz (San Diego, California), for helpful photocopies, B. A. Marshall (Museum of New Zealand, Wellington) and E. H. Vokes (Tulane University, New Orleans) for comments on the first draft.

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# A NEW SPECIES OF THE GENUS *CAECUM* (PROSOBRANCHIA: MESOGASTROPODA) FROM SOUTHERN BRAZIL

R. S. ABSALÃO<sup>1</sup>

(Accepted for publication, May 21st 1994)

**Abstract:** A new species of *Caecum* have been found on the Southeastern Brazilian coast, between 21°–23° S. *Caecum* (*Elephantulum*) *massambabensis* n.sp. is diagnosed by its size (6 mm), increasing diameter towards aperture, absence of spiral sculpture and dominance of very fine longitudinal striae.

**Key words:** Taxonomy, Brazil, Mesogastropoda, Caecidae, *Caecum*, *Elephantulum*.

## INTRODUCTION

Two pioneering works by Rios (1975, 1985) have catalogued the marine molluscs of Brazilian waters. However, several new species have recently been described (Absalão & Rios 1987, McLean, Absalão & Cruz 1988, Absalão 1989, Absalão & Cruz 1990) suggesting that knowledge of the Brazilian marine malacofauna is still relatively incomplete.

Information on the small species is particularly sketchy due, in part, to the low number of researchers working with them (e.g. Marcus 1953, 1955, 1957, Marcus & Marcus 1963, Klappenbach (1964), Mello & Maestrati (1986) and Leal (1991). Despite this, the diversity of small molluscs is high. Absalão (1989), working with molluscs smaller than 10 mm length, identified 184 species from 12 samples collected in the continental shelf area between the northern Rio de Janeiro State (23° S) and southern Espírito Santo State (21° S). This included nine species belonging to the genus *Caecum* Fleming, 1813. One of these appeared to be undescribed and is the subject of this paper.

## MATERIAL EXAMINED

The material studied is deposited in the Malacological collections of Zoology Department, Biology Institute, Universidade Federal do Rio de Janeiro, and at the Museu Oceanográfico de Rio Grande (MORG). Taxonomic treatment follows Moore (1962, 1969, 1970, 1972), Abbott (1974), Keeler (1981), Rios (1985), Leal (1991) and Lightfoot (1992a,b). The subgeneric assignments follows Abbott (1974) Rios (1985) and Lightfoot (1992a) and has based in septum and mucro morphology.

**Abbreviations:** IBUFRJ, Instituto de Biologia da Universidade Federal do Rio de Janeiro (Brazil); LACM, Los Angeles County Museum; MORG, Museu Oceanográfico Eliézer de Carvalho Rios da Fundação Universidade do Rio Grande (Brazil); USNM, National

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Museum of Natural History (Washington); MZUSP, Museu de Zoologia da Universidade de São Paulo (Brazil); MNHN, Muséum National d'Histoire Naturelle (Paris); MNRJ, Museu Nacional do Rio de Janeiro (Brazil); and BM(NH), British Museum (Natural History) (London); BNRVSO, Brazilian Naval Research Vessel SubOficial Oliveira; BNRVAS, Brazilian Naval Research Vessel Almirante Saldanha.

# SYSTEMATIC DESCRIPTION

CAECIDAE Gray, 1850

*Caecum* Fleming, 1813

***Caecum (Elephantulum) massambabensis* n.sp.** (Fig. 1 A,B,C)

**Diagnosis:** Teleoconch relatively big (around 6 mm), strong and moderately curved, increasing diameter towards aperture. No trace of spiral sculpture but with microscopic longitudinal striae interrupted by growth annulations.

**Description:** The teleoconch of *Caecum massambabensis* is a cylinder with a thick wall, strong and slightly curved. The size ranges from 4.5 to 7.0 mm. The shell tapers a little from the anterior to the posterior end. The septum is strongly concave. The mucro is conical and pointed, placed on the left when seen from dorsal side. The aperture is circular, and very gently constricted, without any terminal varix. The colour is cream, but in dead shells may be whitish.

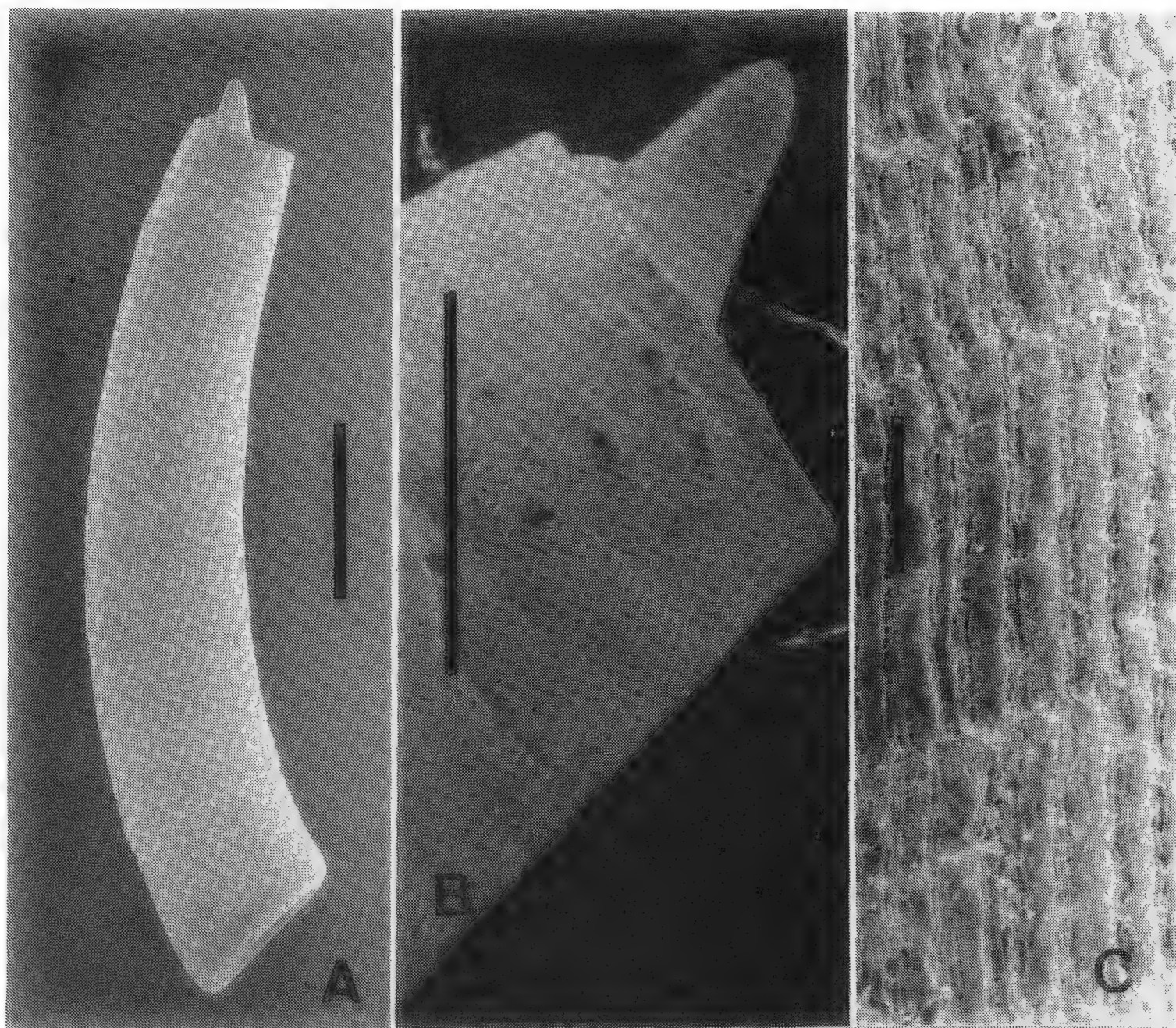


Fig. 1. *Caecum (E.) massambabensis*. **A.** Holotype; scale bar = 1.0 mm. **B.** Mucro view; scale bar = 0.5 mm. **C.** Sculpture details; scale bar = 0.1 mm.



On the shell surface there are numerous very fine longitudinal striae interrupted by unevenly spaced growth annulations.

The protoconch, operculum and radula are unknown.

*Types and type locality:* One lot with 22 adult specimens collected off Massambaba Beach, Rio de Janeiro State, Brazil (22°57'30" S, 42°19'30" W). 31 m, collected by BNRVSO on 25/03/86 (Holotype, Fig. 1A and Paratypes 1–10, 12–22). One lot with 1 adult specimen (Paratype 11) collected off Massambaba Beach, Rio de Janeiro State, Brazil (22°35'00" S, 40°50'00" W), 77m, collected by BNVRSO on 27/03/84. The holotype IBUFRJ 5518 is a dead shell in good condition. Paratype 1 IBUFRJ 5519. Paratype 2 LACM (still without a number). Paratype 3 IBUFRJ 5520. Paratype 4 MORG 30588. Paratypes 5 USNM 860307. Paratype 6 MZUSP 27915. Paratype 7 BM(NH) 1993132. Paratype 8 MNRJ 6882. Paratype 9 MNHN. Paratype 10 MORG 30589. Paratype 11 MZUSP 27916. Paratype 12 MORG 30590. Paratype 13 MNRJ 6883. Paratype 14 IBUFRJ 5521. Paratype 15 IBUFRJ 5522. Paratype 16 IBUFRJ 5523. Paratype 17 IBUFRJ 5524. Paratype 18 IBUFRJ 5525.

*Etymology:* From Massambaba, a native name given by the now locally extinct Indian people (probably Tupinamba) for the region of the Rio de Janeiro State, where most of the specimens were obtained.

*Discussion:* There are five species of the subgenus *Elephantulum* Carpenter, 1857 known from Brazil (Rios, 1985): *Caecum breve* Folin, 1867; *Caecum cycloferum* Folin, 1867; *Caecum floridanum* Stimpson, 1851; *Caecum imbricatum* Carpenter, 1857 and *Caecum plicatum* Carpenter, 1858.

*Caecum breve* is markedly shorter than *Caecum massambabensis*, and has numerous axial cords, a large varix near the aperture and a mammiform septum. In contrast to *Caecum massambabensis* there is no axial cord nor a varix near the aperture, and the septum is not mammiform.

Although, *Caecum massambabensis*, has the same general length as the remainder of species of the subgenus occurring in the South Western Atlantic, it can be distinguished from them by not having microscopic longitudinal ridges, as in *C. cycloferum*, nor axial ribs that are characteristics of *C. floridanum*, *C. imbricatum* and *C. plicatum*.

The microscopic longitudinal striae very much resemble those of *C. (Brochina) strigosum* Folin, 1867, but *C. massambabensis* differs from it by its pointed mucro and an aperture diameter that is clearly bigger than the remainder the shell, whereas *C. strigosum* has a prominent, almost mammilated, septum and an aperture diameter that is only slightly bigger than the remainder of the shell.

*Caecum massambabensis* cannot be easily confused with any other member of the subgenus *Elephantulum* by virtue of its slight curvature and its characteristic ornamentation lacking any kind of strong axial sculpture.

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# A NEW SPECIES AND A NEW RECORD OF *CHELIDONURA* FROM THE RED SEA (CEPHALASPIDEA: AGLAJIDAE)

N. YONOW<sup>1</sup>

(Accepted for publication, May 21st 1994)

**Abstract:** Examination of recently collected specimens, accompanied by colour photographs, of two species of aglajids from the Red Sea reveals one to be new to science and the second to be a new record for the region. The new species *Chelidonura livida* n. sp. is formally described and the taxonomic positions of other species confused with it are discussed. The Red Sea aglajid fauna is briefly reviewed: to date five species are recognized, belonging to three genera, of which three species appear to be endemic.

**Key words:** Opisthobranchia, Cephalaspidea, Aglajidae, *Chelidonura livida* n. sp., *Chelidonura sandrana*, Red Sea.

## INTRODUCTION

The genus *Chelidonura* has been discussed at length by Rudman (1973) and the family Aglajidae and its constituent genera and species have been reviewed by Rudman (1974) and Gosliner (1980). The five genera comprise approximately 70 species. To date 19 species are assigned to the genus *Chelidonura*. One species is circum-tropical, three are found in the Atlantic, ten are recorded from the Pacific, three have a limited distribution in the western Indian Ocean, and two are endemic to the Red Sea. Confusion surrounds the identity of *C. africana* Pruvot-Fol, previously recorded from the Red Sea, and variously synonymized with *Navanax aenigmaticus* (Bergh) and *Chelidonura italica* Sordi. In this paper, a new name is assigned to the Red Sea species, as *africana* is a *nomen dubium*. A second species, *Chelidonura sandrana* Rudman, is recorded for the first time from the Red Sea, and represents only the third record for this Indian Ocean species. All the specimens examined in this study have been deposited at the Senckenberg Museum (Frankfurt).

## SYSTEMATIC DESCRIPTIONS

### *Chelidonura livida* n. sp.

Fig. 1

*Aglaja cyanea (nigra)* Engel & van Eeken 1962 (part): 17, E55/342 (Red Sea).

*Chelidonura africana* Yonow 1990: 289, pl. 4 (Red Sea); not *C. africana* Pruvot-Fol 1953: 31, pl. 3, figs. 37–39 (? = *C. italica* Sordi) (West Africa); not *C. africana* Garcia & Garcia 1984: 77, figs. 1–3 (= *C. italica* Sordi) (Spain).

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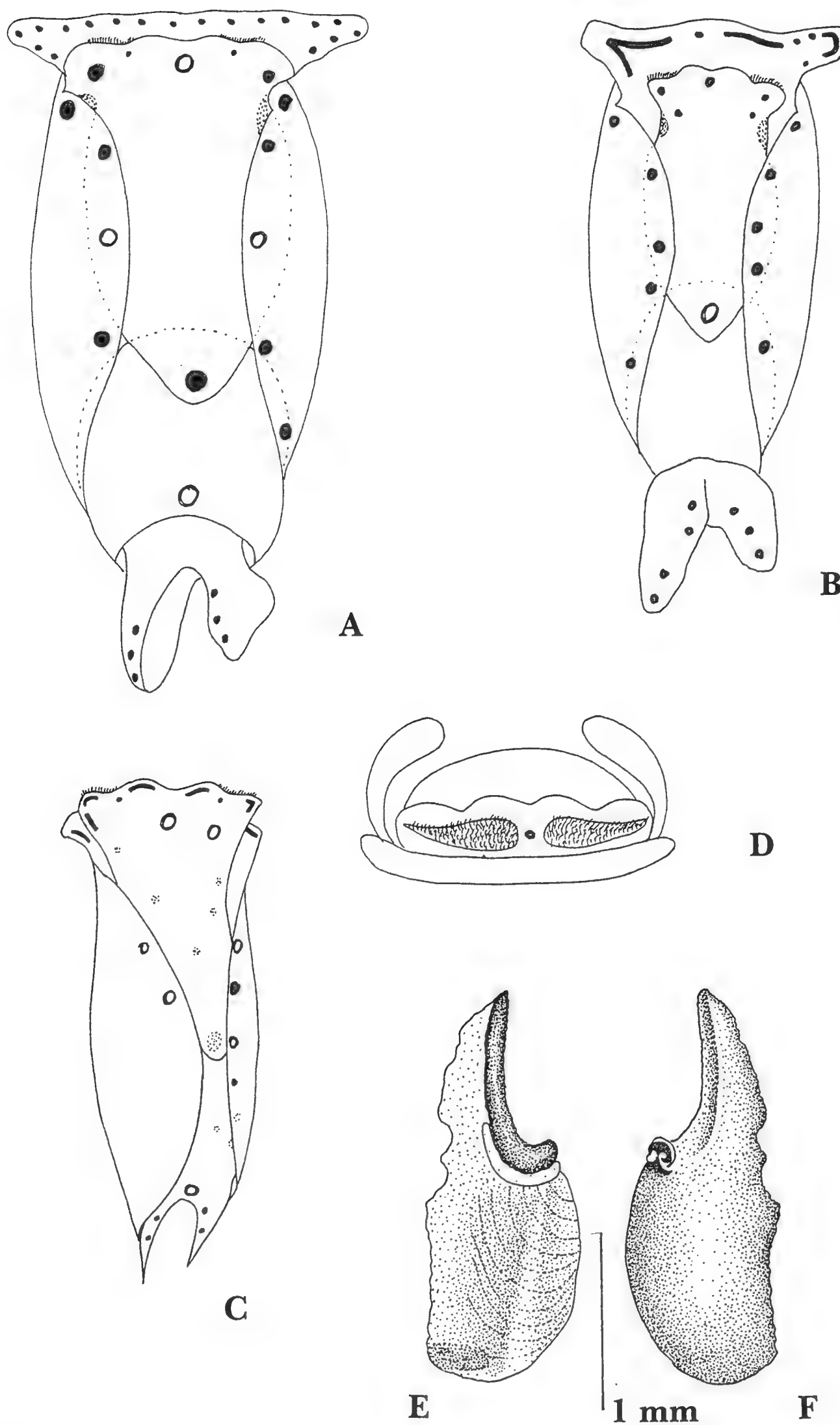


Fig. 1. *Chelidonura livida* n. sp.

A. Drawing from life of holotype.

B. Drawing from life of paratype.

C. Drawing from colour slide of  $12 \times 7$  (grey preserved) specimen (T. Paulus).

D. Frontal view of paratype, drawing from life.

E. Ventral view of shell of paratype (camera lucida).

F. Dorsal view of shell of paratype (camera lucida).

*Material Examined:* Holotype:  $48 \times 14$  mm, north of port, Elat, Israel, 1.5–2 m depth, 10 Aug 1983, N. Yonow (Senckenberg Museum 309934/2).

Paratype:  $50 \times 16$  mm, data as above (SMF 309934/1A) + shell (SMF 309934/1B).

Three specimens, Marine Science Station jetty, Aqaba, 6 m depth on sandy slope, 6



January 1992 (night dive); preserved sizes and colours:  $14 \times 8$  mm (black),  $12 \times 7$  (gray), and  $14 \times 8$  mm (mottled), T. Paulus.

Colour slides of two specimens, not collected,  $32 \times 12$  mm and  $40 \times 10$  mm, Eel Gardens, Ras Nasrani, 15–20 m depth on sandy slope, 20 Mar 1993, 1100 hrs (P. Taylor).

Colour slides of six specimens: Gulf of Aqaba, 5 m depth on sandy and muddy gravel, July and August (J. Hinterkircher), Marine Science Station, Aqaba, 6 m depth on sandy slope, January 1992 (T. Paulus), and Gulf of Aqaba (H. Schmid, H. Schuhmacher).

*Description:* The living specimens are deep chocolate brown to velvety black, with electric blue spots and rings along the edges of the parapodia and shields. Additional blue spots and rings are occasionally present on the shields and parapodia. White flecks are present on the lighter specimens. The head shield has four lobes anteriorly and tapers posteriorly. The posterior shield is oval, with its anterior edge tucked under the head shield and with two short processes on its posterior edge. The left is slightly longer than the right and although they are tubular flaps with the animal is relaxed (Figs. 1A, B), they become straight and tapered when the animal is crawling (Fig. 1C). The parapodia do not meet on the dorsum, and anteriorly there is a large flap extending beyond the head shield which undulates and flaps up and down. In frontal view a single patch of translucent whitish or yellowish bristles is visible on either side of the mouth (Fig. 1D). These bristles are visible when the animal is viewed from above. The broken shell of the paratype is calcified: the callus is heavily calcified with a ridge and a rough lip along its inner edge. The whorl is almost glossy, and growth rings are clearly visible (Figs 1E, F).

In preservative, the three specimens from Aqaba vary considerably. One is black, one is dark grey, and the third is creamy brown with dark patches and a concentration of pigment on the caudal processes. In colour slides of the living specimens, the first is black, the second deep brown black, and the third chocolate brown. These had, respectively, none, few, and numerous white markings.

Drawings prepared from life of the two type specimens, pitch black with blue spots and rings (Figs. 1A, B), provide additional details to the morphology: the line between the frontal 'veil' and parapodial lobes is an acute angle; the lateral edges of the 'veil' bear a line of small blue spots, which may coalesce; on the head shield, there is a paler grey swelling behind each lateral lobe; and finally, there is a ridge present on the dorsal surface of the longer left caudal lobe. The additional photographs can be safely assigned to this taxon: they all depict black animals with blue spots and rings, and a fringe of bristles anteriorly.

Dr. Angelica Haas (Vienna), who worked in Sharm el Sheikh, Sinai, for many years, observed that *C. livida* n. sp. was common in shallow water on sandy substrata in Dahab from April to July. She has also recorded them from Hushasha and Tiran, where they congregated in May and June.

*Discussion:* Two other species of Aglajidae in the Indo-Pacific realm are black with blue markings. *Chelidonura varians* Eliot is black with continuous linear markings along the edges of the parapodia, on both sides of the very long caudal processes, and on the anterior edges and medially on the head shield. To date, it has not been recorded from the Red Sea. One of the colour variations of *Philinopsis cyanea* (Martens) is black with blue edging to the parapodia, at the tip of the head shield, and on the edges of the very short, rounded caudal flaps. This highly predatory species has been recorded from the Red Sea (see Yonow 1990, 1992). *Chelidonura italica* (Sordi) from the Mediterranean and north-eastern Atlantic is also black with blue spots, but is distinguished by its minute size, up to 10 mm in length, and differs in colour patterns (see discussion under *Chelidonura africana* (q. v.)). *Chelidonura sandrana* Rudman is black with orange and white mottling (very intense in the Red Sea specimens), but is also much smaller, less than 14 mm (q. v.).

Etymology: “*Livida*” is from the Latin “*lividus*” and refers to the bright blue colour of the lines, spots, and rings.

***Chelidonura sandrana* Rudman, 1973 Fig. 2**

*Chelidonura sandrana* Rudman 1973: 208, figs. 2, 3E, F, 4, 5; Yonow 1994.

*Material Examined*: Three specimens, Marine Science Station, Aqaba, 4 m depth on sandy/silty sea bed with short sea grasses, May 1990, 7–10 mm (T. Paulus).

Colour slides of four specimens, data as above, 2 m depth.

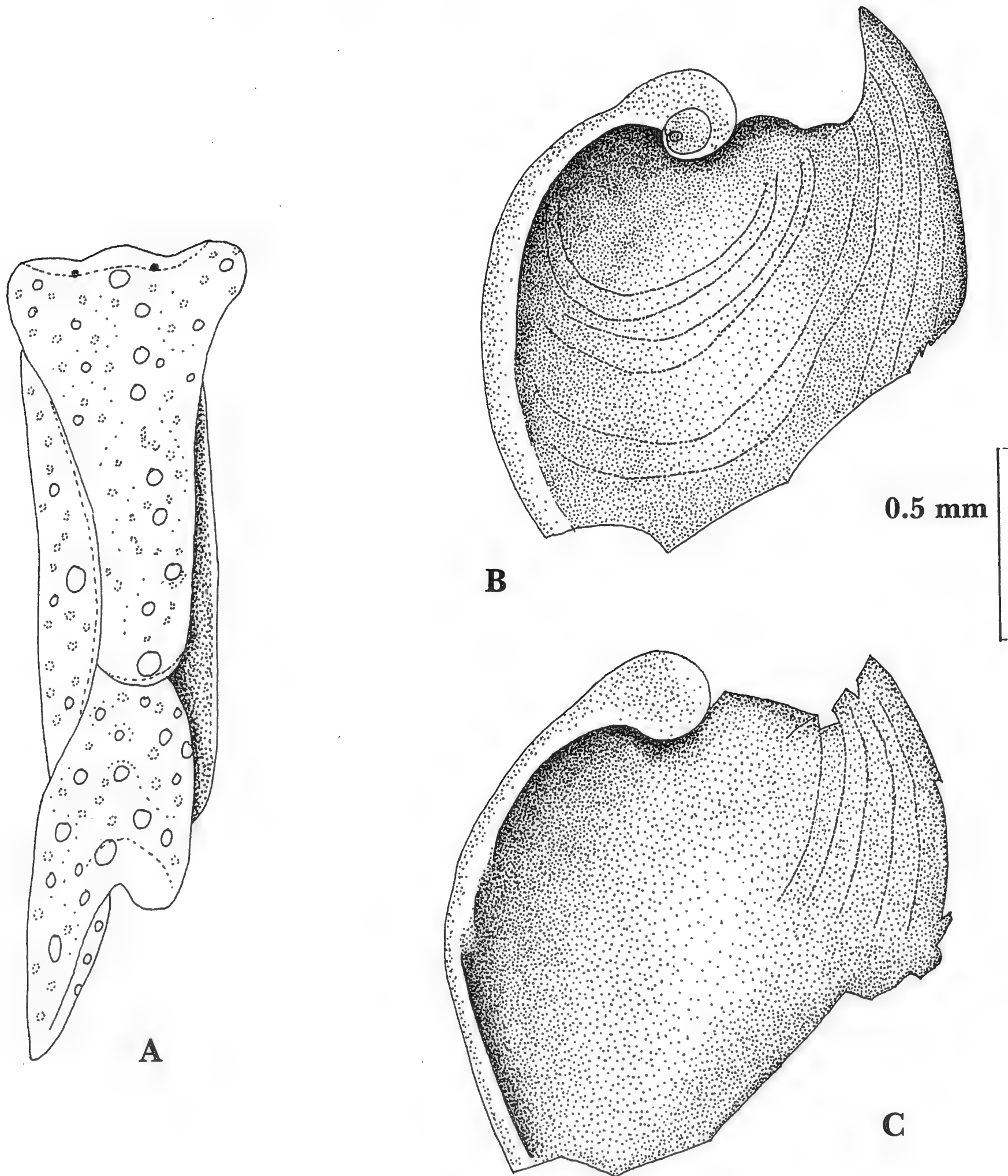


Fig. 2. *Chelidonura sandrana*  
A. Drawing from colour slide (T. Paulus).  
B. Ventral view of shell (camera lucida).  
C. Ventral view of shell (camera lucida).

*Description:* This small species, less than 10 mm total length in Red Sea specimens, is black with orange spots and white flecks and streaks (Fig. 2A). The head shield is elongate oval, tapering posteriorly and trilobed anteriorly. An unpigmented region is present anteriorly in which the eyes are located; there is a sharp undulating demarcation between the unpigmented area and the black. Posteriorly, the end of the head shield is edged with white. The posterior shield is oval, its anterior edge usually tucked under the head shield. There is a left caudal process, a thick short triangular flap, while the right is absent, present simply as a rounded bulge. The shield is generally spotted with orange and white, with no white edging. The parapodia are held close to the body and do not meet. The edge bears a thin patchy white line which is sometimes discontinuous. Anteriorly the parapodia form funnels either side of the head shield. The shell is broadly oval, calloused at its coil and leading edge, and sharply pointed at its tip (Figs. 2B, C). The callus is beige brown while the rest of the shell is translucent.

The preserved specimens are translucent grey brown.

*Discussion:* This species was originally described from Zanzibar and subsequently recorded from the Maldivian islands (Yonow 1994) with slight variations in colour pattern and tail length. The Indian Ocean specimens ranged from pure black to black with white petaloid patches with orange centres and black with numerous white streaks and patches, some of the larger ones with orange spots centrally. In addition, they had longer, tapering left caudal processes. However, only the Maldivian and Red Sea specimens appear to have the distinctive lack of pigment across the anterior edge of the head shield.

Very similar to *C. sandrana* is a Mediterranean species, *C. italica* Sordi (1980). Also minute in size, up to 10 mm, it is very dark with patches of white, a translucent area at the head, and a white patch at the tip of the head shield. It has, in addition, blue spots on the parapodial edges and on the frontal veil and a thin orange line along the edges of the parapodia (see further discussion under "*C. africana*").

**"*Chelidonura africana*" Pruvot-Fol, 1953**

*Chelidonura africana* Pruvot-Fol 1953: 31, pl. 3, figs. 37–39.

Pruvot-Fol (1953) briefly described and illustrated three specimens from West Africa as a new species, *Chelidonura africana*. They were black with white flecks, a white anterior edge to the head shield, and an orange line edging the parapodia and caudal processes. Figs. 38 and 39 both show blue spots, anterior bristles, and pointed caudal processes; fig. 37 lacks these. However, the head shields of figs. 37 and 38 are identical in their shape, with a bilobed posterior edge lacking in fig. 39. Marcus (1976) regarded *C. nyanyana* Edmunds (1968) from Ghana as a junior synonym of Pruvot-Fol's taxon, and distinguished between this species and *Aglaja evelinae* (Marcus) (= *Navanax aenigmaticus* (Bergh)). However, Rudman (1974), in his review of the Aglajidae, considered both Pruvot-Fol's and Edmunds' taxa to be *incertae sedis*. Subsequently, Gosliner (1980) concluded that *C. africana* Pruvot-Fol represented two species, one of which belonged to the genus *Navanax* (Pruvot-Fol figs. 38 and 39) while the other remained undetermined (Pruvot-Fol fig. 37), that *C. nyanyana* Edmunds was a synonym of *N. aenigmaticus* (Bergh), and that since *aenigmaticus* from Panama bore orange spots like *africana*, *africana* became a junior synonym of *aenigmaticus*.

Concurrently, Sordi (1980) described *C. italica* sp. nov. from the Mediterranean, which was similar in coloration to *africana* (especially Pruvot-Fol figs. 38 and 39). Garcia & Garcia (1984) described and illustrated in detail *C. africana* from the Straits of Gibraltar, and discussed the possibility that Pruvot-Fol had figured three different species: fig. 37 they assigned to their species, fig. 38 to the genus *Navanax*, and fig. 39 to the genus *Chelidonura* (using Gosliner's own definition of the genus). They also concluded that *C. italica* Sordi was a synonym of their *Chelidonura africana*.



A search through the typothèque at the Museum National Histoire Naturelle (Paris) by the author produced no type specimens of *C. africana* Pruvot-Fol. Therefore, as it is generally felt that *africana* represents more than one species, which has been variously synonymized, and that the name can not be restricted to a specimen of a single species, the taxon is best regarded as a *nomen dubium*. The three figures probably represent the same “très petites espèces” (Pruvot-Fol 1953, p. 31) in various states of relaxation (*Chelidonura* can withdraw its bristles) and are possibly the same species as the small one recorded from the Mediterranean Sea and Iberian peninsula (Sordi 1980, Garcia & Garcia 1984, Ballesteros *et al.* 1986, Cervera *et al.* 1988 and Martínez *et al.* 1993). They are too small (Pruvot-Fol states that her specimens were adults) and the colour pattern, shell shape, and body shape are too different for it to be *Navanax aenigmaticus*. The identity of Pruvot-Fol’s species cannot be unequivocally established, but *Chelidonura italica* is available for the Mediterranean and east Atlantic species described by Sordi (1980) and subsequently recorded by Garcia & Garcia (1984), Ballesteros *et al.* (1986), Cervera *et al.* (1988), and Martínez *et al.* (1993). *Navanax aenigmaticus* remains valid for the Atlantic species variously described as *C. nyanyana* and *C. evelinae* (Edmunds 1968, Marcus 1955, Thompson 1977), and the Red Sea species of *Chelidonura*, represented by none of the above, is in need of a name and here described as *C. livida* n. sp.

#### AGLAJIDS CURRENTLY KNOWN FROM THE RED SEA

In the many collections of opisthobranchs from the Red Sea, species of Aglajidae have been rarely recorded. Table 1 lists the aglajids described to date from the Red Sea. The new species and the new record reported upon here bring the total of Red Sea aglajids to five species. Engel & van Eeken (1962) gave colour notes for two lots of specimens of *Aglaja cyanea* from Elat: E55/342 are probably conspecific with *Chelidonura livida* n. sp., and E56/178 are most probably *P. cyanea*. Three species are endemic to the Red Sea while *C. sandrana* is present in the western Indian Ocean and *P. cyanea* is a widespread Indo-Pacific species.

TABLE 1

<i>Aglaja phaeoreticulata</i> Yonow	Yonow 1990: 289, pl. 3, fig. 2
<i>Chelidonura flavolabata</i> Heller & Thompson	Heller & Thompson 1983: 327, fig. 4C
	Yonow 1984: pl. 33, fig. 2
	Yonow 1990: 290, pl. 5
<i>Chelidonura sandrana</i> Rudman	this paper
<i>Chelidonura livida</i> n. sp.	this paper
	Engel & van Eeken 1962: 17 (part)
	Yonow 1990: 289, pl. 4
<i>Philineopsis cyanea</i> (Martens)	Engel & van Eeken 1962: 17 (part)
	Yonow 1990: 290, pl. 6
	Yonow 1992: 1999, fig. 1

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# FOSSIL LAND SNAILS FROM A HELLENISTIC ARCHAEOLOGICAL SITE IN LIBYA

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**Abstract:** A wine amphora found inside a sarcophagus from a cemetery site in Cyrene, Libya contained ten species of fossil land snails. The artifacts within the sarcophagus suggest an age between 475 and 375 BC indicating a period c. 150 years after the city was established by the Greeks. The majority of the land snails are species found today within the region suggesting little substantial change in the environmental conditions at the site. The records confirm that *Poiretia compressa* (Mousson, 1859) has been present in Libya since the period 475–375 BC. Its disjunct distribution probably arises from human introduction into Africa, and our evidence suggests that this occurred relatively early in the colonization of the region.

**Key words:** Fossil land snails, Archaeology, Libya, Human introduction, *Poiretia compressa*.

## INTRODUCTION

This paper presents additional palaeoenvironmental data from an archaeological site at Cyrene, Libya. The original excavations were carried out between 1956–1957 by the University of Manchester (Rowe 1959). Cyrene [= Shahat] was an important Greek colony which was founded in about 630 BC in the region of what is now Cyrenaica in western Libya (Fig. 1a). This area was occupied by the Greeks through Classical and Hellenistic periods as well as by the Romans. The city of Cyrene lies 8 km inland from the coast, and in ancient times it was connected by a road to its port, Apollonia, 19 km to the north-east. It lies on the edge of the Gebel Akdar, a limestone plateau which extends for nearly 150 km running parallel with the coast (Fig. 1a). The site was colonized largely because of its good defensive location and its constant supply of water. The city was occupied from 631 BC passing into Roman rule in 96 BC. In 115 AD fortunes began to change and the city suffered from civil unrest, earthquakes and invasions, which led to phases of rebuilding and fluctuations in the population. The city was seized by the Arabs in 643 AD.

The land snails of the region of Cyrenaica were revised by Brandt (1956 a & b, 1958, 1959) and Zilch (1951, 1960). This work showed that the land snails of the region have affinities to the eastern Mediterranean fauna, but are also distinct with a large number of endemic taxa. Numerous new taxa were described by these authors, some of which are present at this site.

The genus *Poiretia*, which is largely found in the eastern Mediterranean region, was last revised by Subai (1980). He found that *Poiretia compressa* (Mousson, 1859) had a disjunct distribution with the main distribution from S. Albania and W. Greece, but with additional populations in N. Libya, which he thought had been introduced by humans.

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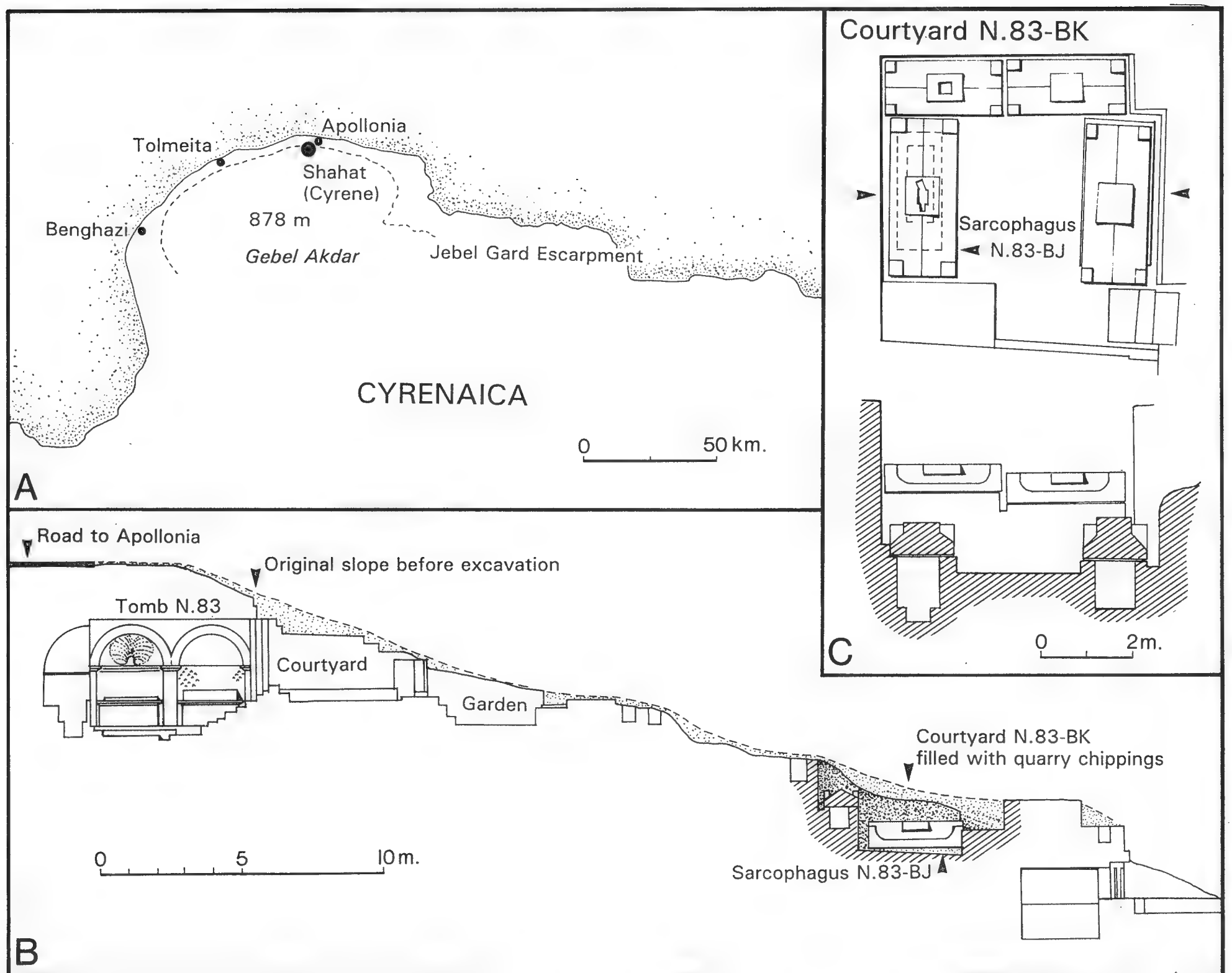


Fig. 1.

a. Top map shows the region of Cyrenaica, with the escarpment of Jebel Gard and the towns of Cyrene and Apollonia. b. N.E. Cemetery site excavated by Rowe. c. Detail of the courtyard where the sarcophagus was found.

### ARCHAEOLOGICAL CONTEXT

The city of Cyrene was excavated during the last century and, more extensively, in this century (Rowe 1959). The majority of the visible excavating remains belong to the Roman period but the layout of the site is essentially Hellenistic. Rowe's excavation was carried out in the northern cemetery, one of four main areas of burials which cover many square kilometres of territory around the walled city (Cassels 1955, Fig. 1). The main area excavated lies on the northern side of the ancient road between Apollonia and Cyrene (on a north-facing slope which runs down to the lower plateau; Fig. 1b). The fossil land-snails came from the sarcophagus burials around the area of rock-cut tombs N.81 and N.83 (Fig. 1b; Cassels 1955, p. 27, Fig. 4). The main area of discovery was a 21' square enclosure, Rowe's N.83-BK, cut deep into the natural rock and surrounded by four sarcophagi (Rowe 1959, p. 12, pls. 6 a, b, fig. X-XII). The enclosure had been filled with quarry chippings (Rowe 1959, Plate a), most probably deriving from the enlargement of the Hellenistic tomb N.83 to the south. This particular tomb is important for the Christian inscription over the grave of Demetria, a victim of the earthquake of 365 AD.

FOSSIL LAND SNAILS

The land snail assemblages described here were discovered by J. Thorn in May 1987 during a review of the material in Manchester Museum. The most abundant source of fossils came from a wine amphora (M.745), although there were shells from other parts of the excavation. These shells had apparently adhered to the interior wall of the amphora which had not been cleaned since it was removed from the sarcophagus at the time of excavation. These shells eventually fell off the inner wall, forming a detritus on the bottom. The wine amphora came from one of the concealed sarcophagi, Rowe's N.83-BJ on the eastern side of the enclosure (Rowe 1959, Plate b) and was most probably found lying on its side on the top of the burials (Rowe 1959, p. 14, Plate 7b). Ten species of land snail are represented. (Table 1).

TABLE 1

Land snails recovered from Amphora M-745, Cyrene, Libya

Species	Fossil Shells	Modern Records
<i>Pleurodiscus</i> cf. <i>klemmi</i> Brandt, 1958†	156	Libya (see taxonomic notes)
<i>Paramastus edentatus</i> (Sturany, 1908)*	1 + 4 juvs.	Libya (see taxonomic notes)
<i>Parmacella festae</i> Gambetta, 1925†	10 + 2 juvs.	N. Libya to Egypt (Wiktor 1983)
<i>Eopolita forcarti</i> Brandt, 1957*†	261	Libya (see taxonomic notes)
<i>Cecilioides</i> cf. <i>acicula</i> (Müller, 1774)†	4	Europe (England, Scandinavia southwards to Mediterranean region (Sicily, Malta)
<i>Cecilioides</i> cf. <i>jani</i> (de Betta & Martinati, 1855).†	13	EC. and S. Europe from N. Italy and Czechoslovakia to Sicily, Malta, Greece and SE. Asia Minor
<i>Rumina decollata</i> (L., 1758)*†	48	Widespread, Circum Mediterranean and human introduction elsewhere.
<i>Barcania</i> cf. <i>kaltenbachii</i> Brandt, 1956*	24	Libya (see taxonomic notes)
<i>Poiretia compressa</i> (Mousson, 1859)	56	Albania, Greece and Cyrenaica (Subai 1980)
<i>Helix melanostoma</i> (Draparnaud, 1801)	4	Widespread, largely eastern Mediterranean, but also introduced elsewhere.
Total number of shells	c.583	

Footnotes:

Nomenclature follows Riedel (1980), Wiktor (1983), Subai (1980) and Brandt (1956, 1958).

† Species recorded from narrow-necked jug M.1173 in area N.81-RR

\* Species recorded from modern samples collected at the site.

Other shells were recovered from a narrow-necked jug (M.1173) from an undisturbed burial in the smaller sarcophagus (N.81-RR). An infestation of land snails was also found above the cremated remains in this sarcophagus (N.81-RR) but these are all species represented from the larger sample above (Rowe 1959, p. 8, pl. 26c).

The preservation of the shells was good, although the calcrete coating which covered the majority of shells, protecting the diagnostic shell microsculpture, had to be removed to allow identification. The nomenclature below follows a variety of papers (as listed in the table), as there is no single paper on the region. The modern range of each species is also given in the adjacent column, showing the number of local endemics. Voucher specimens have been deposited in the collections of the Zoology Department, National Museum of Wales (NMW.Z. 1993. 050.), but most of the material is held in the Manchester Museum.

Within the samples the most common species were *Eopolita forcarti*, *Pleurodiscus* cf. *klemmi* and *Rumina decollata*. The first two are endemic to the region, as are the less common species *Parmacella festae*, *Paramastus edentatus* and *Barcania* cf. *kaltenbachii*. The other species are more widespread in the eastern Mediterranean, such as *Rumina decollata* and *Helix melanostoma*.



Two additional species were recorded living at the site, *Sphinterochila* sp. and '*Xerocrassa*' sp., as well as many of those recorded in the fossil assemblage (see species \* in Table 1).

### TAXONOMIC AND IDENTIFICATION NOTES

#### Family Enidae

*Paramastus edentatus* (Sturany, 1908). Although only one complete shell was obtained from the amphora, the species was collected from other archaeological samples on the site, and is common there today. There are several species of *Paramastus* known from the region (Zilch 1951, Brandt 1958), but *P. edentatus* can be recognised by its small tapering shell with a less strongly developed lip.

#### Family Pleurodiscidae

*Pleurodiscus* cf. *klemmi* Brandt, 1958. The eastern Mediterranean species of this genus have been reviewed on the basis of shell characters by Zilch (1969), Giusti (1973) and Bank & Menkhorst (1991). Zilch (1969, p. 231) regarded *Pleurodiscus klemmi* from Cyrenaica as a species distinct from the more widespread *Pleurodiscus balmei* (Potiez & Michaud, 1838). Bank & Menkhorst (1991) record both species from Libya on the basis of material collected by Brandt and deposited in the Senckenberg Museum. *P. balmei* is known from one locality further west towards Benghazi, whereas *P. klemmi* was found in the region of Shahhat and Apollonia. There are several other species from the eastern Mediterranean including *P. cyprius* (Kobelt, 1896) from Cyprus and *P. sudensis* (Pfeiffer, 1846) from Crete. *P. klemmi* has a larger shell with less prominent sculpture than *P. balmei*. The fossil shells from the Amphora are similar in shape and size to the species known from the region, *P. klemmi*, but have sculpture which is closer to that of *P. balmei* from Greece (Melvill-Tomlin Collection, National Museum of Wales NMW.Z. 1955, 158. 1809). The shells are listed as *Pleurodiscus* cf. *klemmi* Brandt, 1958 pending review of fresh material from other localities in the Mediterranean.

The habitat of *P. balmei* is described as living amongst rocks thus it is likely that these shells indicate similar habitats.

#### Family Parmacellidae

*Parmacella festae* Gambetta, 1925 is one of two species of *Parmacella* known to occur in Libya. The other *P. olivieri* Cuvier, 1804 differs in its larger size, protoconch sculpture and shape (Wiktor 1983, Manganelli & Giusti 1993). Both species are found through to Egypt, preferring similar habitats, that is on bare earth under large stones.

#### Family Zonitidae

*Eopolita forcarti* (Brandt, 1957). The genus *Eopolita* has three species from the Eastern Mediterranean and Middle East including Turkey, Cyprus, Syria, Lebanon, Iran, Iraq (Riedel 1980). This species from Cyrenaica is the westernmost member of the genus.

#### Family Ferussaciidae

*Cecilioides* spp. There are taxonomic problems with the genus *Cecilioides* and these shells are tentatively identified as widespread Mediterranean species, following Giusti (1973), pending a full revision of the N. African taxa. There were two taxa present at the site; the smaller shell is like *Cecilioides acicula*, the widespread north European species which has been reported from Sicily and Malta, whereas the more common species has a larger shell like *Cecilioides jani*. The latter species has a more southern range. These species are essentially subterranean and are known to live at depth in soil, consequently there are frequent records from grave-yards and burial situations.

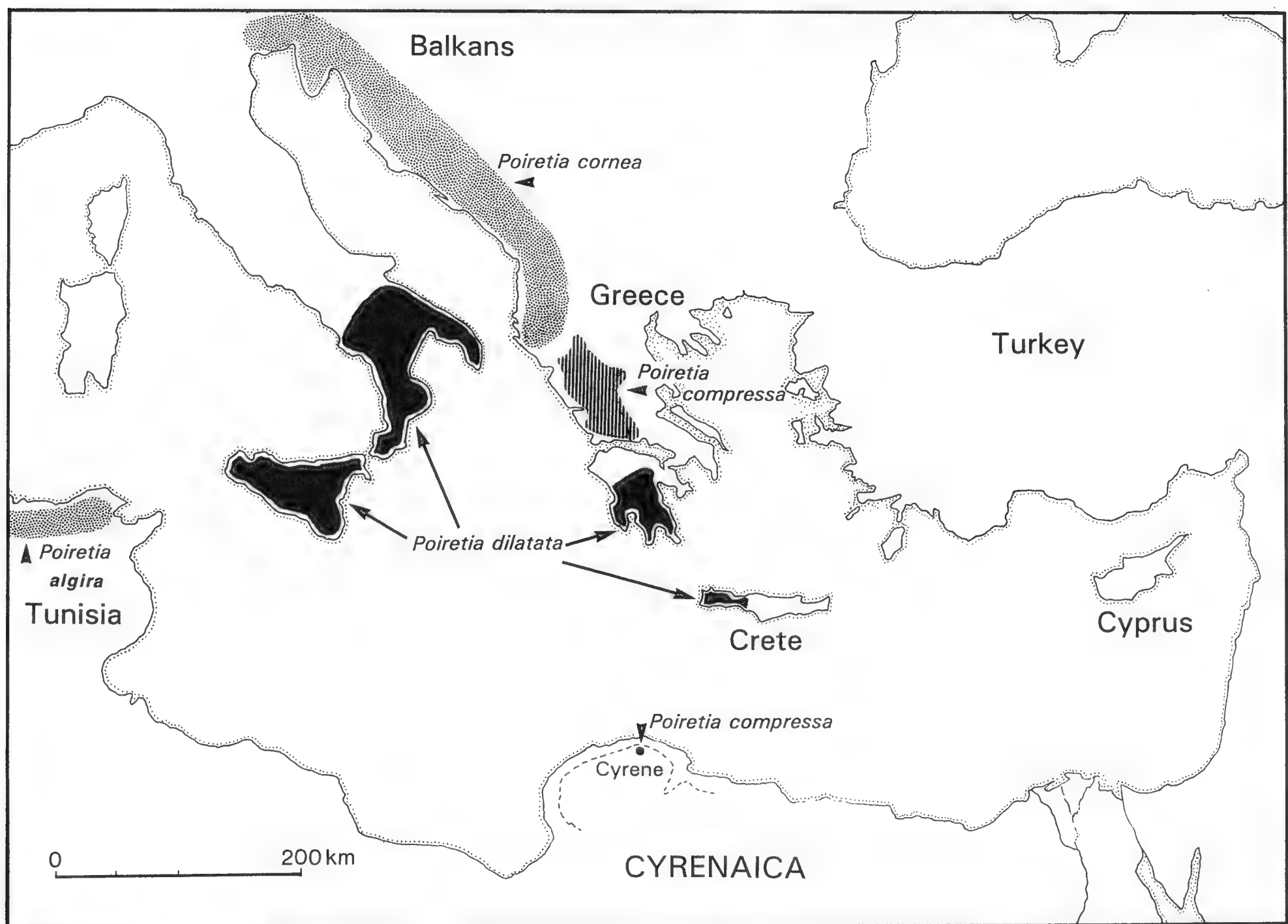


Fig. 2. Distribution of species from the genus *Poiretia* in the eastern Mediterranean region.

#### Family Clausiliidae

*Barcania* cf. *kaltenbachii* Brandt, 1956. The genus *Barcania* Brandt, 1956 was described from the region of Cyrenaica, and includes many species or subspecies. Their ranges are often small. The species from this site was most similar to *Barcania kaltenbachii kaltenbachii* Brandt which has a range which stretches from just east of Cyrene to Tolmetta (Fig. 1a).

#### Family Oleacinidae

*Poiretia compressa* (Mousson, 1859). There are two species of *Poiretia* in N. Africa. *P. compressa* is restricted to the region of Cyrenaica in Libya. The more widespread species is *Poiretia algira* (Brugière, 1792) with a range from North Algeria and North Tunisia (Fig. 2; Subai 1980). Material from the Holyoak-Seddon collection (National Museum of Wales) suggests that this species prefers humid, shady places, often beneath boulders or amongst rocks that provide concealment in crevices. Most of the N. African sites where *P. algira* was found were at low elevations (although the highest was in a gorge at 1140 m) in limestone and base-poor sandstone regions. Several sites were shaded by trees or bushes but others had only herbs and grasses. Thus it is likely that *P. compressa* has similar preferences in NE. Africa.

#### PALAEOENVIRONMENTAL SIGNIFICANCE

The majority of the species can be found under stones on bare earth especially on rocky slopes. Some of the species have more catholic habits, and can be found from rock crags to town gardens (e.g. *Rumina decollata* and *Helix melanostoma*). Species of *Cecilioides* are

subterranean, and thus it is not unusual to find them in burial situations. The common species at this site are all still present today. There is thus no evidence for changing environments from the land snails recorded.

### DATING EVIDENCE

The site was used for burials in both the Hellenistic period and during the period of Roman occupation, with the last burial in this area around 365 AD. The evidence of the burial of Demetria in 365 AD. provides a date *ante quem* for the enclosure to have been buried in the quarry chippings (Bacchielli 1992 p. 16–22, Figs. 6, 14). The fifty-six artifacts (M.745–801) recovered from the sarcophagus N.83-BJ included two coins which have now been re-dated to 475–375 BC (Healey in Rowe 1959 p. 32, xvii and xviii). Thus, on the basis of the numismatic evidence the Amphora containing these shells was apparently placed in the sarcophagus in the period 475 to 375 BC and the area was last used for burial around 365 AD after which it was filled with quarry chippings.

An olpe (wine jug) M.790 containing terra rossa (hillwash) and fossil land snails, was also found in the sarcophagus. Although Rowe (1959) argued that the sarcophagus had been sealed by plaster since closure, the presence of hillwash suggests that the sarcophagus was partially open allowing shells incorporated into hillwash to enter at some later date. The archaeological evidence suggests that the sarcophagus was opened several times for different burials before burial in the chippings (Fig. 3). Thus if the sarcophagus was not sealed properly it is possible that the snails entered the amphora long after it was placed there.



Fig. 3. Photograph showing the position of the sarcophagus and the overlying sediments which infilled the courtyard.



There is however, some evidence which would suggest that the land snails are likely to have entered soon after the amphora was placed in the sarcophagus.

(a) The shells and the amphora are covered with a layer of lime encrustation suggesting that the shells were present within the amphora for the considerable amount of time. This layer suggests a humid or waterlogged phase to create suitable conditions for the lime crust to form.

(b) There was no evidence of hillwash within the amphora M.745 containing the main assemblage. The hillwash was restricted to the olpe M.790, which was apparently near to the top of the sarcophagus.

(c) The high concentration of shells within the amphora suggests that the land snails may have been attracted to the site, possibly by a residue of wine within the amphora.

### DISTRIBUTIONAL IMPLICATIONS

It has been speculated that the disjunct distribution of *Poiretia compressa* was caused by human introductions (Subai 1980). The main centre of distribution is Albania and western Greece. *P. compressa* is also present on the western Greek islands. The records reported here confirm that it was present in Cyrenaica from the period of Hellenistic occupation onwards. This record is for the period 475–375 BC, which is about 150 years after initial colonization by the Greeks. Given that the city of Cyrene is only 19 km from the port of Apollonia and that there was continued traffic between the two countries in antiquity, it is likely that the species was introduced by the Greeks.

There are other cases of possible human introductions along the north African coast. Some of these are for small species which are being recorded with greater frequency, such as *Hawaiiia minuscula* (Binney) and *Helicodiscus singleyanus* (Pilsbry) (Seddon & Holyoak 1993). Other records include larger species such as *Zonites algirus* (L.) which is presumed to be native only in western Asia Minor. *Z. algirus* was first described by Linnaeus who gave the type locality as 'Mauritania' [= Algeria]. Poiret (1789) also reported it from N. Algeria with a more precise locality of La Calle and other populations are known from S. France and S. Italy (Seurat 1930). Riedel (1973 pp. 51–52, 1980) suggested that the populations probably have arisen from introductions and ascribed the Algerian records to accidental importation in the sixteenth century with hay from S. France.

Other disjunct distribution patterns (Algeria and Balkans) of Mediterranean land snails are apparently the result of Tertiary micro-plate movement (Giusti & Manganelli 1984), but the endemism within the region of Cyrenaica and the lack of suitable micro-plate movement would argue against this explanation for *P. compressa*. Other explanations include range fragmentation due to Pleistocene climatic change (Seddon *et al.* 1993), but the present distribution pattern of species in the genus *Poiretia* and absence of fossil evidence from the eastern Mediterranean would argue against this.

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# A REVIEW OF THE LAND SNAILS OF RODRIGUES ISLAND (INDIAN OCEAN) WITH NOTES ON THEIR STATUS

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*Abstract:* In 1986 and 1989 a land snail survey was carried out on Rodrigues. This was followed up by examination of collections in the Natural History Museum, London (NHM) including that of Dr E. H. Madge. A total of 27 native snails were recorded, of which 5 species were extinct and a further 3 species probably extinct. A total of 11 introduced snails and slugs were recorded.

*Key words:* Rodrigues, non-marine Mollusca, conservation status.

## INTRODUCTION

The island of Rodrigues is the smallest and most isolated of the Mascarene islands. It is a volcanic island formed some 2 million years ago (McDougall *et al.* 1965), and has an area of 109 km<sup>2</sup>. The nearest island, Mauritius, lies 650 kms to the west.

Rodrigues has long attracted scientific interest. As a mid-oceanic island its fauna and flora have a high degree of endemism (Strahm 1991). With the serious degradation of the natural environment through forest clearing on a massive scale, and over-population, interest has centred on trying to save those endemics threatened with extinction. Such work has to date concentrated on the flora and vertebrate fauna with little work being done on the equally distinctive invertebrate fauna. In July 1986, a survey was undertaken of Rodrigues to determine what native snails survive, their status and present distribution. The survey was completed during a second trip in June 1989. In 1992, the author also examined the collection and notes of Dr E. H. Madge (at the Natural History Museum) who worked extensively on Mascarene snails, and also had access to a small collection of Rodrigues snails made by D. Florens in 1993.

Rodrigues, because of its isolation, has a depauperate but nonetheless interesting land snail fauna. Until 1873, only one species was known, but in that year, as a result of a shipwreck that left him stranded for 3 months, a young naturalist, M. A. Desmazes, made the first thorough collection of Rodrigues snails. He collected a total of 15 snail species, 8 of which were subsequently described by Crosse (1874). Soon after that, an ornithologist, Mr M. Bewsher, examining particularly the fossil birds of Rodrigues, collected 14 snails species, 3 of which were described by Morelet (1875).

The *Transit of Venus* expedition to Rodrigues in 1874 made a major survey of the snails, finding 16 species of which one was new (Smith 1879). In the following century only 4 more new species were described (Connolly 1925, Laidlaw 1937, Madge 1946). Rodrigues has a known fauna consisting of 42 species of non-marine snail (Germain 1921, Connolly 1925, Laidlaw 1937, Madge 1946, Starmühlner 1983). In terms of their origins and affinities, these snails fall into 3 groups: larger less easily dispersed species that are endemic but have close

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affinities to Mauritian and Réunion taxa, smaller wind-dispersed species that are native, but have a wider distribution, and the fresh-water species, most of which have a wide distribution.

The survey had as its objective the examination of the status of all the indigenous non-marine gastropods, as well as surveying the introduced species. A total of 30 sites was visited during two, week long periods in 1986 and 1989 with a thorough collection being made at each site (see map).

As most of Rodrigues is totally denuded of native vegetation, the survey concentrated on areas of remnant forest and those areas such as limestone caves and coastal dunes known to be suitable habitat. In each survey site, the presence of all snails was noted and a determination was made of their status. The categories for this were based on the IUCN's threatened species categories, that is 'Extinct' (Ex); 'Endangered' (E); 'Vulnerable' (V); 'Insufficiently Known' (K), or otherwise, 'Secure'. By looking at the proportion of live to dead snails, their abundance and their distribution (whether widespread or localised) a fairly accurate status report can be made. Those species considered as extinct, are species that have only ever been known from sub-fossil specimens, or have not been recorded for many years. The higher taxonomy at a family, subfamily and generic level is based on Zilch (1959–60), for the pulmonates and Wenz (1938–44) for the prosobranchs.

## RESULTS

Terrestrial species. The species are listed in taxonomic order. Key. En: endemic to Rodrigues, N: native but not endemic.

### Family Helicarionidae Subfamily Ereptinae

1. *Ctenophila vorticella* (Adams, 1868) (N)  
 Status: Probably extinct. This species has in Rodrigues only ever been recorded as a sub-fossil. Can still be found in limestone scree at the entrances to caves in the S.W.  
 Localities: Caverne Tamarin, Caverne Patate.
2. *Louisia barclayi* (Benson, 1850) (N?)  
 Status: Common, secure. This small snail occurs very commonly in leaf litter and on tree trunks throughout most of the forested upland areas. That it is absent from the limestone scree of the S.W. caves and is abundant in the upland *Terminalia* plantations suggests that it may have been introduced from Mauritius on forestry service seedlings.  
 Localities: Solitude, E of Les Choux, Mt Lubin, Mt Cimetière, Mt Limon.
3. *Plegma bewsheriana* (Morelet, 1875) (En)  
 Status: Extinct. This, the largest of the Rodrigues snails is described from sub-fossil state amongst limestone scree at the entrances to caves in the S.W. of the island. The presence of 1 old dead specimen under a rock overhang at Mont Cimetière indicates it once probably ranged over the entire island.  
 Localities: Caverne Tamarin; Caverne Patate; Mt Cimetière.

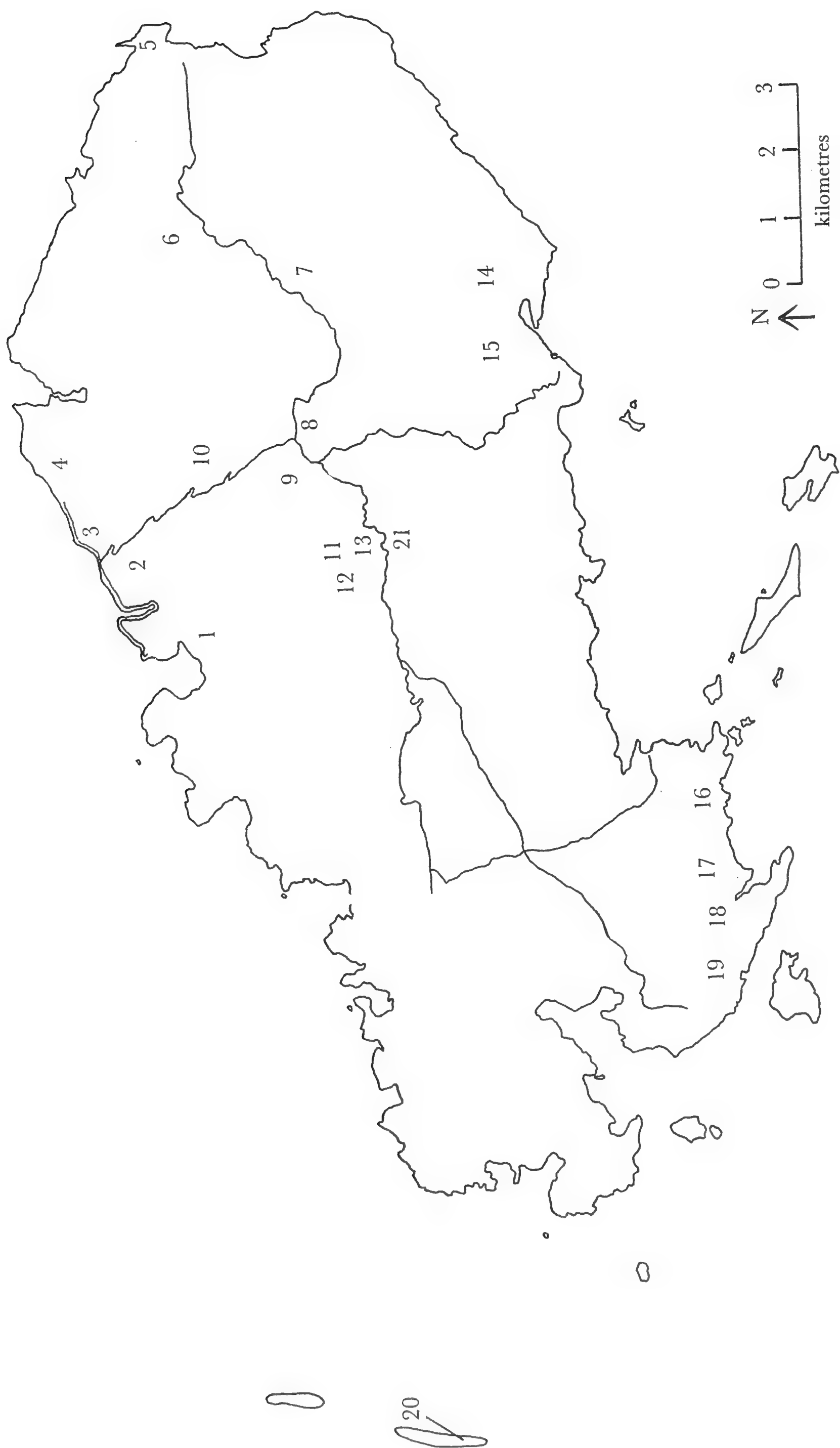


Fig. 1. Map of Rodrigues Island showing the location of the sampling sites. 1. Baie aux Huîtres, 2. Port Mathurin, 3. Pointe Venus, 4. Anse aux Anglais, 5. Pointe Cotton, 6. Roche Bon Dieu, 7. Grande Montagne, 8. Mont Limon, 9. Mont Lubin, 10. Solitude, 11. Les Choux, 12. Mont Cimetière, 13. Rivière Mourouk, 14. Cascade Victoire, 15. Cascade Mourouk, 16. Caverne Patate, 17. Caverne Tamarin, 18. Anse Quittor, 19. Plaine Corail, 20. Ile Cocos, 21. Cascade Malartic.

4. *Plegma (Areocaelatura) rodriguezensis* (Crosse, 1873) (En)  
 Status: Moderately common, localised, vulnerable. This snail is now restricted to the remaining forested areas of the island, where in some areas it is quite common under deep piles of leaf litter.  
 It occurs in large numbers in a sub-fossil state in the limestone caves of the SW. Sub-fossil snails are larger than living ones.  
 Localities: Collected alive or fresh dead at: Mt Malartic, Grand Mountain, Mt Limon, Mt Cimetière;  
 Sub-fossil: Caverne Tamarin, Caverne Patate.
5. *Thapsia (Gudeella) snelli* Connolly, 1925 (En)  
 Status: Vulnerable, common but very localised. This snail occurs commonly in leaf litter, adhering to the underside of dead leaves at Grand Mountain. Occurs very uncommonly in areas of remaining forest at Mt Cimetière. Also occurs as a sub-fossil in the limestone caves of the S.W.  
 Localities: Live: Grand Mountain, Mt Cimetière.  
 Sub-fossil: Caverne Patate, Caverne Tamarin.

### **Subfamily Helicarioninae**

6. *Colparion madgei* Laidlaw, 1938 (En)  
 Status: Probably extinct. This species was described from living specimens. The survey failed to locate any recent specimens although sub-fossil specimens were found in the limestone scree at the entrance to Caverne Patate.  
 Type locality: Cascade, Malartic Valley.  
 Locality: Sub-fossil: Caverne Patate.

### **Family Streptaxidae** **Subfamily Ennoinae**

7. *Gonospira metableta* (Crosse, 1874) (En)  
 Status: Secure, common. This is the largest of the Rodrigues carnivorous snails and occurs under rocks, logs and leaf litter wherever patches of the forest provide suitable shelter. Also occurs in a sub-fossil state at Caverne Patate.  
 Localities: Live: Les Choux, Rivière Marouk, Grand Mountain, Cascade Victoire, Mt Climetière, Mt Limon, Solitude.  
 Sub-fossil: Caverne Patate.
8. *Gonospira rodriguezensis* (Crosse, 1875) (En)  
 Status: Moderately common, probable secure. Although Germain (1921) regarded this as only a small form of *G. metableta*, the 2 species co-exist, often under the same log, and within the same locality are always easily separated on the basis of size. It is thus here retained as a valid species.  
 Occurs with *G. metableta* wherever patches of forest provide suitable shelter. Also occurs as a sub-fossil in the limestone caves. It is much less common than *G. metableta*.  
 Localities: Live or freshly dead – Rivière Marouk, E. of Les Choux, Solitude, Anse aux Anglias, Sub-fossil: Caverne Tamarin, Caverne Patate.
9. *Gonospira chloris* (Crosse, 1873) (En)  
 Status: Common, secure. As with *G. metableta* this species is found commonly under



GRIFFITHS: LAND SNAILS OF RODRIGUES ISLAND

rocks, logs and leaf litter wherever there is forest to provide suitable shelter. Also occurs as a sub-fossil in the limestone caves of the S.W.

Localities: Live: Mt Limon, Grand Mountain, Les Choux, Mt Malartic, Mt Cimetière, Rivière Marouk.

Sub-fossil: Caverne Tamarin; Caverne Patate.

**Subfamily Enneinae**

10. *Streptostele acicula* (Morelet, 1877) (N?)

Status: Insufficiently known. Madge (1939) regarded this species as introduced to the Mascarenes although this may not be so, as it occurs on Mauritius in sub-fossil deposits. Three specimens, all freshly dead, have been collected in Rodrigues, where it is probably introduced, as it was not found on Rodrigues in deep sub-fossil deposits.

Localities: Caverne Tamarin, Mt Limon.

**Family Ferrussaciidae**

11. *Geostilbia mauritiana* (Adams, 1868) (N)

Status: Insufficiently Known. First recorded in Rodrigues by Madge (1946) from fresh dead specimens at Oyster Bay. Only old dead specimens were collected during the survey, coming from scree at the entrance to the limestone caves.

Localities: Caverne Tamarin, Caverne Patate.

**Family Succineidae**

12. *Quickia concisa* (Morelet, 1848). (N)

Status: Secure, common. This snail is found commonly in many areas of the island, particularly in grass and leaf litter in coastal areas.

Localities: île Coco, Caverne Patate, Caverne Tamarin, Pt Mathurin, Pt Venus.

**Family Chondrinidae**  
**Subfamily Gastrocoptinae**

13. *Gastrocopta microscopica* (Nevill, 1878) (N)

Status: Secure, common. A snail with a wide distribution, but occurring most commonly in coastal and limestone areas.

Localities: Plaine Coraile, Caverne Patate, Point Venus, Caverne Tamarin, Point Cotton, Roche Bon Dieu, île Coco.

14. *Gastrocopta lienardi* (Crosse, 1873) (N)

Status: Insufficiently known. This snail recorded by Crosse from Rodrigues and which occurs on Mauritius was not encountered during the survey.

**Family Pupillidae**  
**Subfamily Pupillinae**

15. *Costigo desmazuresi* (Crosse, 1875)

Status: Extinct. This snail occurs in large numbers in a sub-fossil state in the caves of the SW.

Localities: Caverne Patate, Caverne Tamarin.

**Family Vertiginidae**  
**Subfamily Nesopupinae**

16. *Nesopupa rodriguezensis* (Connolly, 1925) (N)  
Status: Uncertain. This snail which occurs commonly in coastal areas of Mauritius, was recorded by the survey only from limestone scree in a sub-fossil state.  
Locality: Caverne Patate.
17. *Nesopupa micra* (Pilsbry, 1920) (N)  
Status: Common secure. This small snail occurs commonly on dead *Ravenala* fronds, and as a sub-fossil in limestone scree.  
Localities: Live E. of Les Choux, Sub-fossil: Caverne Patate, Caverne Tamarin.

**Family Tornatellinidae**  
**Subfamily Auriculellinae**

18. *Elasmias jauffreti* (Madge, 1946) (En)  
Status: Insufficiently known. This snail was described from sub-fossil and fresh dead specimens collected in 1939. The survey collected only sub-fossil specimens from the limestone caves.  
Localities: Caverne Patate, Caverne Tamarin.

**Family Enidae**

19. *Rachistia* sp. Near *Rachistia sanguinea* (Barclay) from Mauritius. (N)  
Status: Extinct. Known only from sub-fossil specimens collected at Caverne Patate and Caverne Tamarin.  
New record from Rodrigues.

**Family Veronicellidae**

20. *Semperula maculata* (Templeton, 1858). (N?)  
Specimens from Rodrigues were described as *Veronicella rodriguezensis*. Hoffman (1925) synonymised this with *S. maculata*, a slug with a wide tropical distribution. Probably introduced.  
Localities: Collected at Grand Mountain, Solitude, Mt Lubin and Mt Cimitière.

**Family Pomatiasidae**  
**Subfamily Pomatiasinae**

21. *Tropidophora eugeniae* (Reeve, 1857) (N)  
Status: Secure, moderately common, locally abundant.  
Sub-fossil specimens of this snail were described as *T. bipartita* (Morelet, 1875). It was Connolly (1925) who recognised that this was in fact *T. eugeniae*, originally described from Mauritius, where it no longer occurs.  
Localities: Live: Under rubbish and piles of rocks, Les Choux, Mt Limon, Mt Lubin, Mt Malartic, hills behind Anse aux Anglais. Solitude.  
Sub-fossil: Caverne Patate, Caverne Tamarin.

GRIFFITHS: LAND SNAILS OF RODRIGUES ISLAND

22. *Tropidophora bewsheri* (Morelet, 1875) (En)  
 Status: Extinct. Known only from sub-fossil specimens.  
 Locality: Caverne Patate.
23. *Tropidophora fimbriata rodriguezensis* (Crosse, 1873) (En)  
 Status: Vulnerable. This snail was once very common as indicated by the large numbers in a sub-fossil state in the SW and also as recorded by Desmazes "Très abondant à Pt Mathurin" (in Crosse 1874).  
 It is now rare except at Pointe Cotton where it still occurs in large numbers under low bushes on a limestone headland. However, this population must be considered very vulnerable as it occurs only in a tiny area.  
 Localities: Live: Port Mathurin, Pointe Cotton.  
 Sub-fossil: Caverne Patate, Caverne Tamarin, Plaine Corail.
24. *Tropidophora articulata* (Gray, 1834). (En)  
 Status: Vulnerable, uncommon. This snail was once very common as indicated by the high density of sub-fossil shells that can be found in limestone areas of the SW and by historical records (Desmazes in Crosse 1874). During the survey only 6 live specimens were collected.  
 Localities: Fresh dead or Live: Grand Mountain, Anse aux Anglais, Solitude, Mt Malartic, Mt Cimetière, Caverne Tamarin.  
 Sub-fossil: Caverne Patate, Pt Cotton, Roch Bon Dieu, Cavern Tamarin.
25. *Tropidophora desmazuressi* (Crosse, 1973) (En)  
 Status: Probably extinct. Found as a sub-fossil in the Caverne Patate area. No trace was found of this snail at its type locality: Mt Limon. In the Madge collection (WHM) there are fresh specimens labelled: "Anse Quitor, Rodrigues.: Jauffret, 1938".  
 Locality: Caverne Patate, Caverne Tamarin. Anse Quitor.
26. *Leptopoma* sp. (N)  
 Status: Extinct. Known only from sub-fossil specimens collected at Caverne Patate.  
 New record for Rodrigues.  
 Locality: Caverne Patate.

**Family Assimineidae**

27. *Omphalotropis littorinula* (Crosse, 1873) (En)  
 Status: Secure, common. This snail occurs in large number in leaf litter and occasionally on tree trunks in most of the forested areas of the island.  
 Localities: Live: Mt Cimetière, Anse aux Huîtres, Mt Malartic, Mt Lubin, Grand Mountain, Solitude, E. of Les Choux, R. Marouk, Mt Limon.  
 Sub-fossil: Caverne Tamarin, Caverne Patate, Pointe Cotton, Pt Venus.
28. *Omphalotropis taeniata* (Crosse, 1873) (E)  
 Status: Secure, localised. Although regarded by Crosse as uncommon, this snail occurs in large numbers on tree trunks especially *Terminalia* in the upland forests.



Localities: Solitude, E of Les Choux, Grand Mountain, Mt Malartic, Mt Lubin, Mt Cimetière, Anse aux Huîtres.

### FRESHWATER AND BRACKISH WATER SPECIES

Starmühlner (1983) surveyed the fresh water and brackish water snails of Rodrigues and recorded: *Melanoides tuberculata* (Müller, 1774), *Thiara scabra* (Müller, 1774), *Clithon coronata* (L., 1758), *Neritilia consimilis* (Martens, 1879), *Septaria borbonica* (Bory de St. Vincent, 1803), *Neritina gagates* (Lamarck, 1822), *Lymnaea mauritiana* (Morelet, 1875), *Afrogyrus rodriguezensis* (Crosse, 1873), *Paludinella hidalgoi* (Gassies, 1860), *Assiminea nitida* (Pease, 1864), *Melampus lividus* (Deshayes, 1820), *Melampus caffer* (Kustes, 1844). *Truncatella* sp. was collected during the 1989 survey at Pointe Cotton.

The only new record from this survey was the discovery of *Ferrissia* sp. (probably *F. modesta* Barre *et al.* 1982). This was abundant on dead leaves in slow moving streams at Les Choux and Solitude. That they were not recorded by Starmühlner suggests they may have been introduced from Mauritius since the time of the survey.

In the Madge collection at the NHM, there are specimens of the viviparid snail *Bellamya bengalensis* (Lam., 1822) labelled 'Rodrigues Coll R Jauffret, 1940'. These do not appear to have been collected before or since and may have died out on Rodrigues.

In addition to the native snails listed above, 10 species of introduced snail and 2 slugs were encountered during the survey: *Achatina fulica*, *Achatina panthera*, *Macrochlamys indica*, *Opeas pumilum*, *Subulina octona*, *Subulina striatella*, *Zonitoides arboreus*, *Bradybaena similis*, *Pupisoma orcula*, *Euglandina rosea*, and the slugs *Deroceras laeve* and *Meghimatium bilineatum* (Benson).

*Euglandina* is now found over most of Rodrigues including all remaining patches of indigenous vegetation and was introduced in the early 1960's as part of an *Achatina* control programme.

It is quite apparent from the survey that the land snails of Rodrigues have suffered extremely badly since settlement. Of the endemic species, 8 are now extinct, and 4 have small and or localised populations and may be considered endangered.

When one examines the history of Rodrigues it is not surprising that so many snail species have become extinct.

"At the time of its discovery Rodrigues was well wooded and it remained so until the end of the eighteenth century. However, by 1825 the cumulative effects of feral livestock and shifting vegetation since the beginning of permanent settlement in the 1790's had reduced vegetation in much of the island to Savannah.

By 1874 it was written by Balfour that the island was 'now a bare parched volcanic pile with deep stream courses for the most part dry in place of the verdant well watered island of 200 years ago'. The remnants of native vegetation have progressively shrunk so that today only a few hectares survive. Plantations of mixed evergreen species were initiated in 1914" (Checke 1987).

Such habitat destruction described by Checke would clearly account for most of the snail extinctions especially those that may have been confined to lowland forest or forests on limestone.

The surviving natives are either confined to the few native forest patches left or have recolonised areas planted with exotic forest from adjacent native forest patches.

However, in addition to habitat destruction, Rodrigues native snails have had to deal with 2 new predators, both renowned for their impact on native snails – rats and *Euglandina rosea*, the Florida carnivorous snail.

# GRIFFITHS: LAND SNAILS OF RODRIGUES ISLAND

TABLE 1

*Tropidophora articulata* collected in Rodrigues

Station	Live collected	Intact dead shells	Rat-predated shells
Grand Mountain	3	4	7
Rivière Marouk	—	1	4
Mount Malartic	3	3	6
Anse aux Anglais	—	1	65*
Mount Limon	—	6	8
Mount Cimetière	—	—	3
	6	15	93

\* These shells were under a rock overhang in a rat's nest. Many were very old, though some were fresh.

Table 1 gives the breakdown of the individuals of 1 species of *Tropidophora* collected at different stations showing the numbers collected alive, dead but with intact shells, and shells with breaks near the base of spire, indicative of predation by rats. A total of 81% of all deaths can be attributed to rat predation. This suggests that for this species at least, rats may be limiting the size of the population in what is otherwise fairly intact habitat.

The impact of *Euglandina rosea* could also be significant in the decline or extinction of some Rodrigues snails. *Euglandina* is found over most of Rodrigues including all remaining areas of native vegetation. *Euglandina* was commonly found to contain whole shells of both species of *Omphalotropis* in their stomachs. Furthermore, *Euglandina* faeces with *Omphalotropis* shells embedded were seen at Mt Malartic on tree trunks. Similar observations have been made in Mauritius, and *Euglandina* is known to have caused the extinction of native snails in Hawaii and Tahiti (Griffiths, Cook and Wells 1993).

From a conservation strategy viewpoint, it is difficult to make recommendations for Rodrigues snail protection, except to ensure that those remaining areas of native forest are not degraded even further and that *Euglandina* be eliminated from Rodrigues.

## NOTE

At the time of the survey, timber collectors were active in all areas of native forest, except Grand Mountain which is fenced.

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JOURNAL OF CONCHOLOGY, VOL. 35, NO. 2

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# NEW SPECIES OF *PACHNODUS* (GASTROPODA: ENIDAE) FROM SEYCHELLES

J. GERLACH<sup>1</sup>

(Accepted for publication, May 21st 1994)

**Abstract:** The genus *Pachnodus* (Enidae) from Seychelles is reviewed and descriptions of a hybrid form, *P. niger* × *velutinus*, and the new species *P. beckettii* and *P. oxoniensis* are given.

**Key words:** Seychelles, Mahé Praslin, Silhouette, *Pachnodus*, Enidae, hybrid, taxonomy.

## INTRODUCTION

The genus *Pachnodus* (Enidae) is endemic to the Seychelles islands. Several species of the genus have been described by many collectors in the last 150 years. The first of these was by Dufo in 1840, who collected three species from Mahé; *Bulimus ornatus*, *B. niger* and *B. strigilosus* Férussac. Subsequent collectors generally described all species similar in appearance to Dufo's original description of *Pachnodus ornatus* as this species. Pfeiffer (1841) listed two new species (*Bulimus fulvicans* and *B. velutinus*) but the description of the former is too vague to determine the species. Nevill (1868) listed three forms; *Bulimus fulvicans*, *B. fulvicans* var. *nigra* and *Bulimus velutinus*, whereas Martens (1898) recorded *Bulimus (Pachnodes) velutinus* and four varieties of *B. ornatus*; *ornatus*, *niger*, *fulvicans* and *biornatus*. Sykes (1909) only listed two species (*Pachnodus ornatus* and *P. velutinus*) but Barnacle (1968) included three species (*P. ornatus*, *P. fulvicans* and *P. velutinus*) in his list.

Most of the confusion surrounding the species of the genus was cleared by Van Mol & Coppois (1980) who described two subgenera; *Pachnodus* containing *P. velutinus* (Pfeiffer), *P. lionneti* Van Mol & Coppois and *P. niger* (Dufo), and *Nesiocerastus* containing *P. ornatus* (Dufo), *P. silhouettanus* Van Mol & Coppois, *P. fregatensis* Van Mol & Coppois and *P. kantilali* Van Mol & Coppois. In the process of their revision they changed the type locality of *P. ornatus* from Mahé to Praslin, on the basis of the apparent absence of a species on Mahé resembling the type description of this species.

In 1990 the *Nesiocerastus* species on Praslin was described as a separate species, *P. praslinus* Gerlach, following the rediscovery of a species on Mahé that is identifiable as *P. ornatus*.

The genus *Pachnodus* according to the current classification (Van Mol & Coppois 1980) comprises eight species divided into two subgenera; *Pachnodus* (*P. velutinus*, *P. lionneti*, *P. niger*) and *Nesiocerastus* (*P. ornatus*, *P. praslinus*, *P. silhouettanus*, *P. fregatensis*, *P. kantilali*). The subgenera are distinguished by the following characters (Van Mol & Coppois 1980):

<i>Pachnodus</i>	Globosely conical shell; 5 whorls; mouth edge not significantly expanded. Epiphallus short, without ornamentation. Spermathecal duct generally short; spermatophore short, without toothed ornamentation.
<i>Nesiocerastus</i>	Ovately conical shell; 6 whorls; mouth edge expanded into a lip. Epiphallus

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much longer than penis, ornamented with regular ridges. Spermathecal duct long; spermatophore long, with regular toothed ridges.

The distribution of these species are given below:

<i>P. velutinus</i>	Mahé
<i>P. lionneti</i>	Silhouette
<i>P. niger</i>	Mahé and Praslin
<i>P. ornatus</i>	Mahé
<i>P. praslinus</i>	Praslin
<i>P. silhouettanus</i>	Silhouette
<i>P. fregatensis</i>	Fregate
<i>P. kantilali</i>	Mahé

When *P. ornatus* was rediscovered on Mahé, at least two more forms of this genus were discovered that did not seem to be identifiable on current taxonomy. The discovery of these forms led me to review the taxonomic status of the genus as a whole. The results of this review are presented below.

The review was undertaken by collecting a number of specimens from a variety of locations. At least two specimens from each locality were prepared for dissection; preparation was by drowning the snail in boiled water and preservation in 70% ethanol. These were subsequently dissected to provide data on key anatomical features, namely the radular structure, reproductive anatomy and the pigmentation of the mantle, border of the pallial cavity and the rectum. These are all important characters for identification as shown by the detailed anatomical study by Van Mol & Coppo (1980).

#### SYSTEMATIC DESCRIPTIONS

##### *Pachnodus (Pachnodus) niger subfuscus* n. ssp.

*Shell* (Fig. 1): Shell globosely conical with 5 whorls in addition to the two smooth ones of the protoconch; thin (<0.1 mm thick) but strong with a dull surface. Sculpture of well defined irregular spiral ridges and weak radial ones, highly variable in numbers and spacing. The apex is blunt. Columella edge very slightly reflexed over the 1–1.5 mm wide umbilicus. No sutural ridges or lip at the mouth edge. Colouration dark grey-brown.

##### *Dimensions:*

Height: 10.8–15.1 mm (mean: 12.5, sd.: 1.4, n=4)

Diameter: 8.7–13.2 mm (mean: 10.7, sd.: 1.4, n=4)

Mouth height: 8.8–10.7 mm (mean: 9.9, sd.: 0.9, n=4)

*Body:* Body dull grey with tail keel the same colour; mantle grey or black; pallial cavity border light beige; rectum off-white.

*Anatomy:* Radula (Fig. 3): Formula = 162 + 14 + 1C + 14 + 162.

Reproductive anatomy (Fig. 2): Penis longer than appendix, shape simple. Penial retractor muscle attached half-way up penis; spermathecal duct long; spermatheca slightly elongated in shape.

*Distribution:* Praslin; Vallée de Mai (primary palm forest). This species is arboreal, generally being observed 1–2 m above the ground on palm leaves.

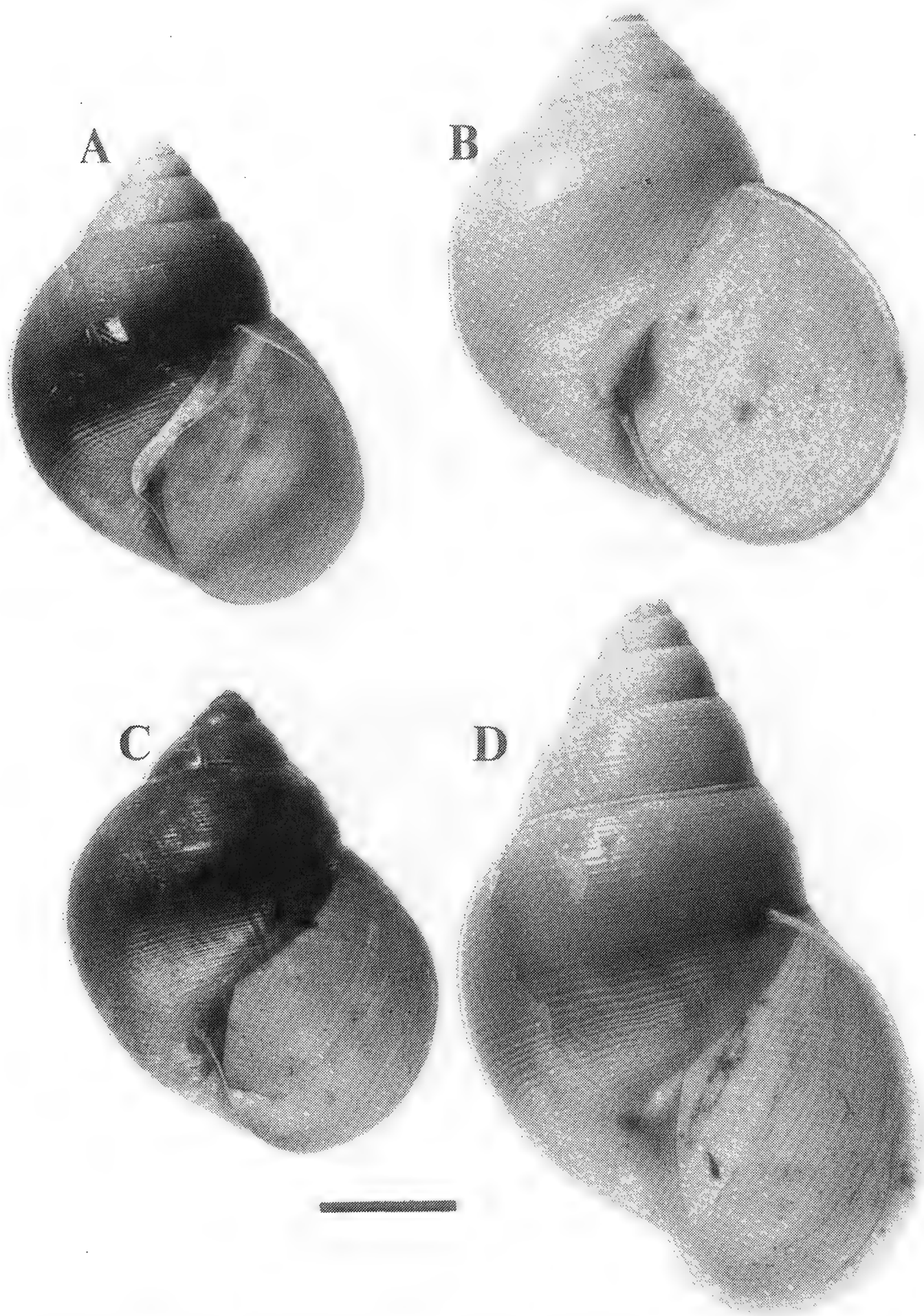


Fig. 1. Shells of: A. *P. niger subfuscus* n. ssp. B. *P. beckettii* n. sp. C. *P. niger* × *velutinus* comb. nov. D. *P. oxoniensis* n. sp. scale bar = 10mm

*Comparisons:* This form differs from the nominate subspecies on Mahé in general colouration, the shell and body being lighter than the typically black Mahé individuals. The relative proportion of the shell dimensions also differ (given in mm below):

		Mahé	Praslin
Height	range	12.2–16.7	10.8–15.1
	mean	14.5	12.5
	sd.	1.4	1.4
	n	6	4
Diameter	range	7.6–10.6	8.7–13.2
	mean	9.0	10.7
	sd.	1.0	1.4
	n	6	4



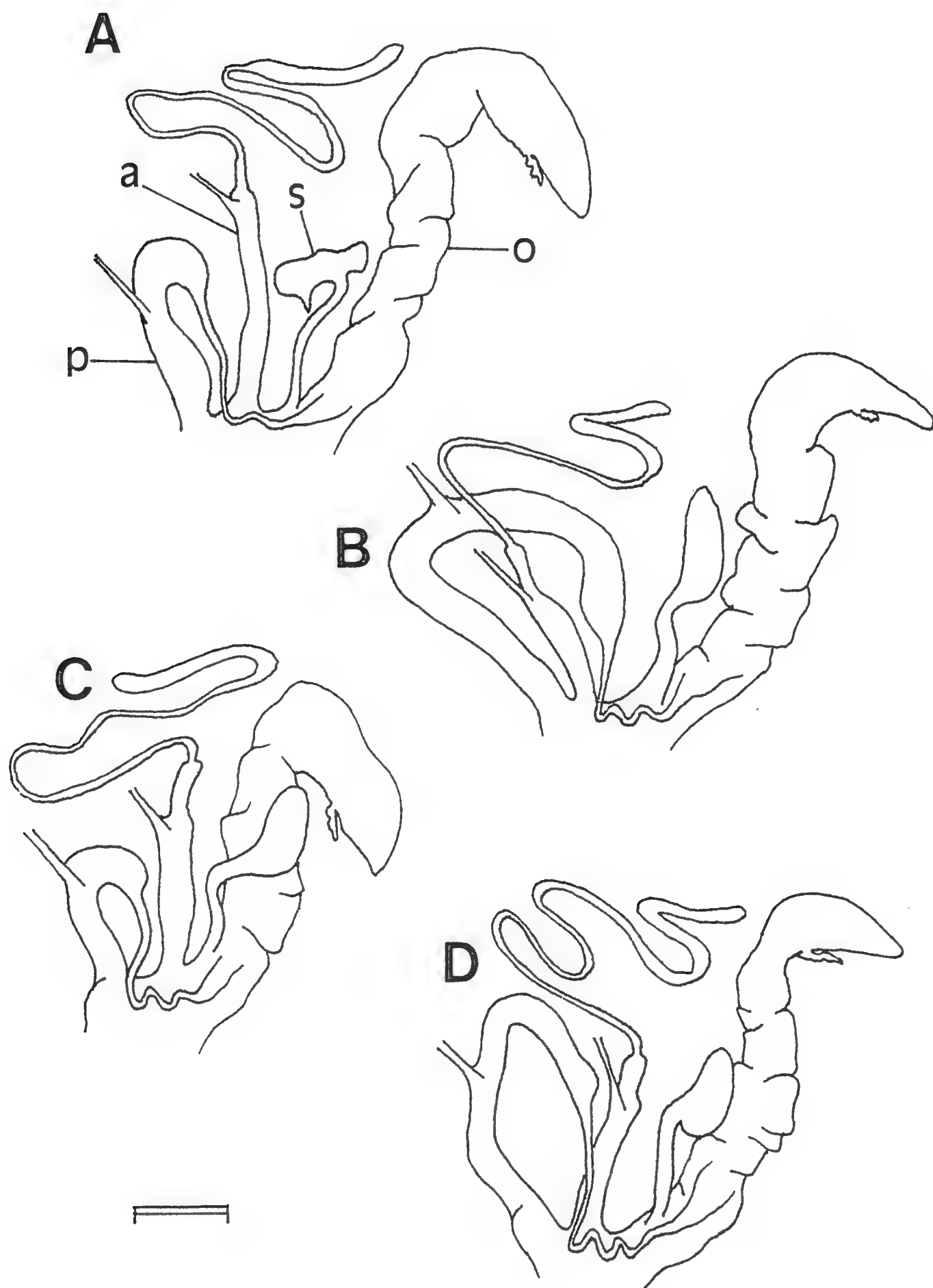


Fig. 2. Reproductive anatomy of: A. *P. velutinus* B. *P. niger* C. *P. beckettii* D. *P. niger* × *velutinus* scale bar = 5mm  
key: a = appendix, o = spermooviduct, p = penis, s = spermatheca

Mouth height	range	8.8–9.1	8.8–10.7
	mean	9.0	9.9
	sd.	0.4	0.9
	n	6	4

There are no significant differences in the reproductive anatomy of the two forms. The radula formulae of the two forms are clearly distinct, as are the shape of the teeth:

	Mahé	Praslin
Formula	181+11+1C+11+181	162+14+1C+14+162

In the absence of any clear differences in reproductive anatomy these populations cannot be considered distinct species. However, the marked differences in their radulae indicate

that the populations have diverged sufficiently to merit subspecific status. Accordingly the Mahé form is the nominate subspecies on account of its original description (Dufo 1840).

*Material studied*: 4 specimens; 4/7/90 (1 holotype in the British Museum (Natural History) – BMNH 1993–083), 9/1/93 (3 measured but not collected).

*Etymology*: The subspecific name *subfuscus* refers to the dull colour of this form.

***Pachnodus (Pachnodus) beckettii* n. sp.**

*Shell* (Fig. 1): Shell globosely conical with a slight depression near the mouth edge of the last whorl in some specimens; thin (0.05–0.1 mm thick) but strong in most specimens although one population (Montagne Planeau) has very fragile shells often damaged in handling. Surface dull with well defined fine spiral ridges and faint irregular radial ones, both variable in number. Five whorls in addition to the two of the protoconch. Apex blunt; slight suture on the last whorl. Columella edge partially covering the 1–1.5 mm wide umbilicus. In most specimens there is a very slight reflection of the mouth edge, in a few specimens this becomes much enlarged producing a distinct lip 1–1.5 mm wide, this is never thickened. Colouration light grey or beige.

*Dimensions*:

Height	range = 12.5–14.3mm mean = 13.4 sd. = 0.8 n = 12
Diameter	range = 10.8–12.1mm mean = 11.3 sd. = 0.7 n = 12
Mouth height	range = 6.9–10.3mm mean = 8.7 sd. = 1.2 n = 12

*Body*: Body colouration fawn; tail keel slightly lighter; mantle grey with white markings; palleal cavity border light beige or off-white with some white markings; rectum banded black and white.

*Anatomy*: Radula (Fig. 3): Formula = 209+11+1C+11+209

Reproductive anatomy (Fig. 2): Penis short and strongly curved over; retractor muscle attaches 3/4 of the way up the penis; appendix long. Spermatheca simple in shape with a short duct. Spermatophore simple in shape, similar to that of *P. velutinus*.

*Distribution*: Mahé; Montagne Planeau (600 m, primary forest patches), Mount Sebert (450–550 m, forest invaded by exotic plants), La Reserve & Brullée (250–500 m, primary palm forest). This species is largely arboreal, being found on shrubs, trees and occasionally on the ground.

This species appears to be most closely related to *P. velutinus* which it resembles in the colouration of the border of the palleal cavity and the banded pattern on the rectum. Both species have short, curved penes and relatively long appendices. They differ in the penial retractor muscle of *P. velutinus* attaching lower down than in *P. beckettii* and the spermatheca are highly distinct. The radulae are also distinctive:

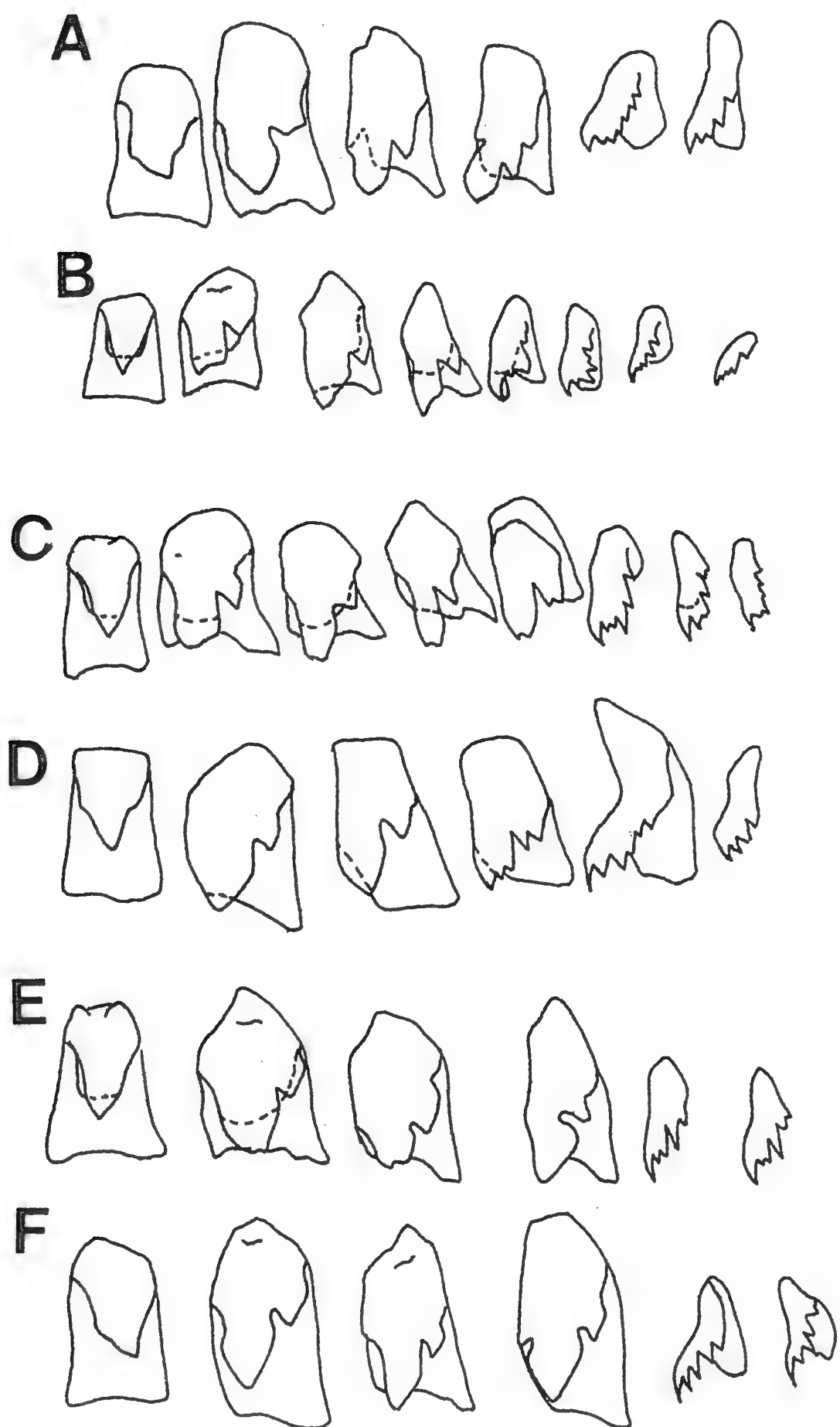


Fig. 3. Radula teeth of (tooth numbers given after each species): A. *P. velutinus* (C,1,9,10,25,100) B. *P. lionneti* (C,1,9,11,12,25,100,150) C. *P. n. niger* (C,1,9,12,16,25,100,160) D. *P. niger subfuscus* (C,1,9,25,30,100) E. *P. niger* × *velutinus* (C,1,9,12,25,100) F. *P. beckettii* (C,1,9,12,25,100)

	Formula
<i>P. beckettii</i>	209+11+1C+11+209
<i>P. niger niger</i>	181+11+1C+11+181
<i>P. niger subfuscus</i>	162+14+1C+14+162
<i>P. velutinus</i>	220+11+1C+11+220
<i>P. lionneti</i>	174+11+1C+11+174

*Material studied:* 12 specimens; 21/7/87 (1 holotype and 2 paratypes in the British Museum (Natural History) – BMNH 1993–082), 1/4/88–1/1/90 (9 specimens in the Nature Protection Trust of Seychelles collection).

*Etymology:* This species is named after Mrs. E. Beckett, a naturalist of Seychelles.



*Pachnodus (Pachnodus) niger* × *velutinus*

*Shell* (Fig. 1): Shell globosely conical; strong but variable in thickness (0.05–1.5mm); surface dull or shiny; spiral and radial ridges variable in number. 5 whorls in addition to the 1.5–2 of the protoconch; ornamented with fine regular radial ridges at the sutures. Apex blunt; umbilicus open (1–1.5mm wide), partially covered by the columella; mouth edge sometimes slightly relexed but never a true lip. Colouration dark reddish brown or black, specimens with fawn shells are very rare.

*Dimensions:*

Height	range = 9.9–14.9mm
	mean = 11.84
	sd. = 1.3
	n = 20
Diameter	range = 9.5–14.0mm
	mean = 11.9
	sd. = 1.3
	n = 20
Mouth height	range = 6.5–11.3mm
	mean = 8.8
	sd. = 1.3
	n = 20

*Body*: Body usually dark grey or black, often lighter on the sides; central region of sole distinctly lighter. Very rare fawn specimens have a pinkish fawn central part of the sole. Mantle grey or brown with white markings; mantle cavity border is off white or beige with distinct pinkish tinge; rectum banded black and white.

*Anatomy*: Radula (Fig. 3): Formula = 188–192+11+1C+11+188–192 the number of marginals appears to be variable.

Reproductive anatomy (Fig. 2): Penis long; retractor muscle attaches approximately half-way up its length; appendix shorter than the penis. Spermathecal duct short. The spermatophore has not been observed.

*Distribution*: Mahé; Trois Frères & Le Niol (250–650m), Mare aux Cochons (250–450m), Mount Coton (400–600m), Casse Dent (370m), Morne Blanc (400–667m), Copolia (400–497m), Grande Anse (150–350m), Bernica (Montagne Palmiste) (100–250m) – all forest areas with exotic plant invasion. This form is found both on vegetation and on the ground.

This form cannot reliably be distinguished from *P. velutinus* or *P. niger* on shell characteristics, as it covers the range of variation found in both species. The black and white banding on the rectum would place it in the *P. velutinus*, *P. beckettii* group whereas its reproductive anatomy suggests close affinity to *P. niger*. The radula formula is highly variable, this is the only *Pachnodus* taxon to show any variation in formula. These differences indicate that it is a distinct form, either an undescribed species intermediate between all the Mahé species or a hybrid. Hybridization seems to be the most likely origin as its characters are intermediate without any evidence of derivation. It has been observed mating with individuals of both *P. velutinus* and *P. niger*, producing viable offspring (pers. obs.) and occupies a geographical position between the two species presumed to be parental.

*Material studied*: 30 specimens; 1/1/87 (2 specimens in the British Museum (Natural History) – BMNH 1993–085), 30/7/87–10/1/90 (28 specimens in the Nature Protection Trust of Seychelles collection).

*Pachnodus (Nesiocerastus) oxoniensis* n. sp.

*Shell* (Fig. 1): Shell ovately conical, >2 mm thick and strong; slightly shiny and crossed by numerous spiral ridges and radial growth lines. Some specimens have a satiny appearance. 6 whorls with an additional 2 smooth or radially ridged ones on the protoconch; slight sutural ridge present. Apex blunt; umbilicus covered by the reflexed columella; strong mouth edge lip up to 3 mm wide. Colouration variable from black with an orange band at the top of each whorl through orange and pink forms to an almost white colour.

*Dimensions:*

Height	range = 27.8–30.0mm mean = 28.8 sd. = 1.0 n = 8
Diameter	range = 15.2–18.1mm mean = 16.5 sd. = 1.0 n = 8
Mouth height	range = 14.1–14.9mm mean = 14.6 sd. = 0.5 n = 8

*Body*: Body colour varies with shell colour. Pale shelled forms fawn or beige; grey tentacles; beige soles. Black shelled forms black with grey central foot region. Mantle beige with white markings; rectum white in all forms. In pale forms pallial cavity border beige, black outside and white inside in black forms.

*Anatomy*: Radula (Fig. 5): Formula = 183+9+1C+9+183.

Reproductive anatomy (Fig. 4): Penis long; epiphallus ribbed just over half its length. Penis approximately four times as long as appendix; retractor muscles joined. Spermatophore not observed but believed to be typical of the subgenus as no specific variation has been recorded in other members.

*Distribution*: Silhouette; Mount Pot a eau (500–621m, primary mist forest), Mount Dauban (600–720m, primary mist forest), *Pisonia sechellarum* forest (450–520m, primary forest). Found on vegetation 1.5–4m above the ground.

*Comparisons*: This species has a broad, thick shell as is found in *P. ornatus* and *P. praslinus*. It differs from the latter in the penial and appendicular retractor muscles being joined. It differs from *P. ornatus* in having ribbing on the upper part of the penis only and in the retractor muscle attaching higher up. The radula is distinct:

	Formula
<i>P. oxoniensis</i>	183+9+1C+9+183
<i>P. ornatus</i>	157+9+1C+9+157
<i>P. praslinus</i>	152+9+1C+9+152
<i>P. silhouettanus</i>	156+9+1C+9+156
<i>P. fregatensis</i>	107+9+1C+9+107
<i>P. kantilali</i>	162+9+1C+9+162

*Material studied*: 8 specimens; 1/4/90 (1 holotype and 1 paratype in the British Museum (Natural History) – BMNH 1993–084), 2/4/90–8/9/90 (6 specimens in the Nature Protection Trust of Seychelles collection).

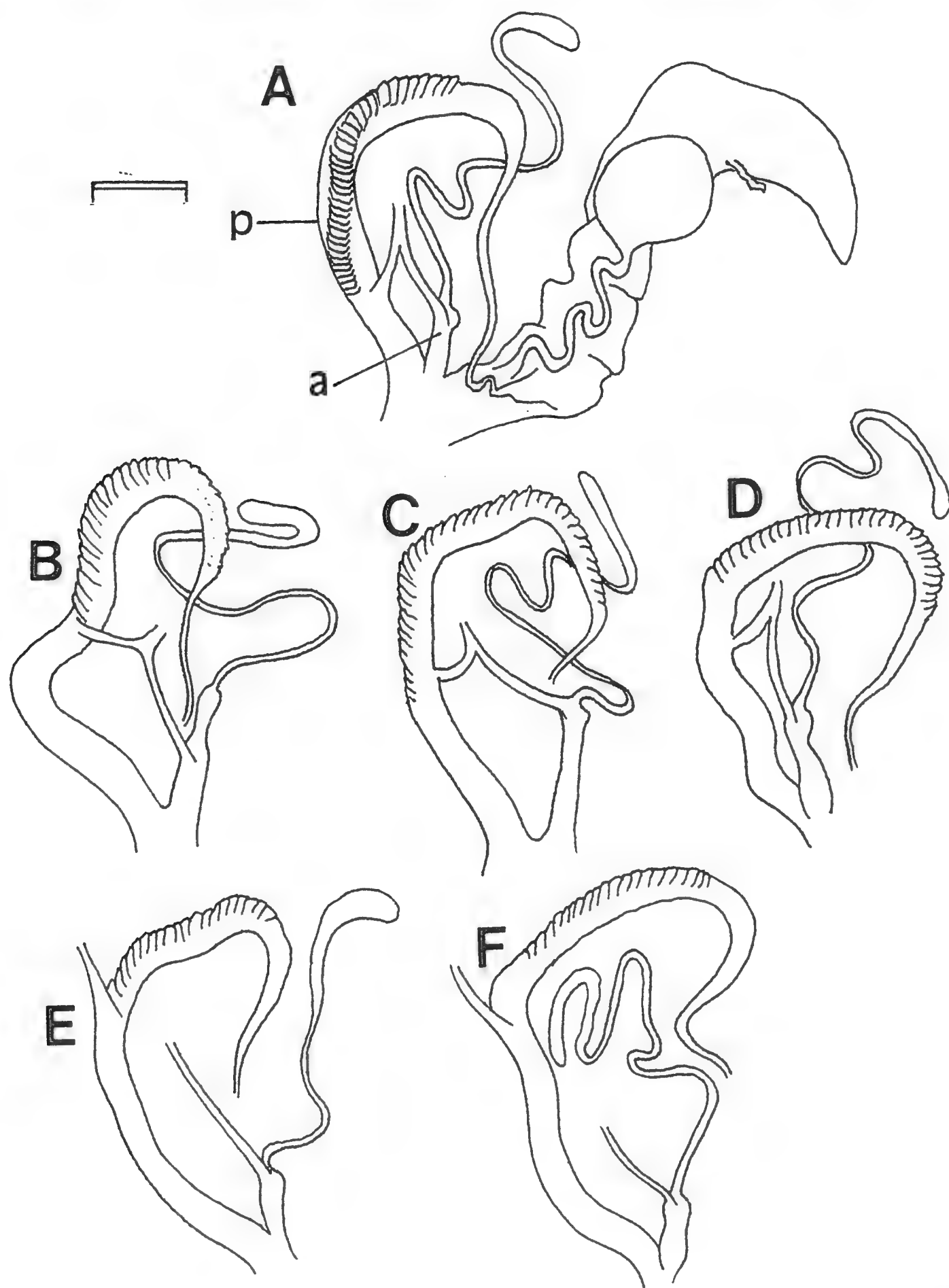


Fig. 4. Reproductive anatomy of: A. *P. ornatus* B. *P. oxoniensis* C. *P. kantilali* D. *P. fregatensis* E. *P. praslinus* F. *P. silhouettanus* scale bar: 5 mm key: a = appendix, p = penis.

*Etymology*: This species is named after the Oxford University Silhouette Expedition 1990 which discovered the species.

An additional species of the subgenus *Nesiocerastus* is recorded from La Digue. Five bleached subfossil shells have been collected. No live specimens have been located and this form may be extinct. The shells appear to belong to an undescribed species, approaching *P. praslinus*. It is not appropriate to describe this species until such time as a thorough search has been made on La Digue to determine if any live specimens remain.

*Notes on colouration*: In several species (*P. lionneti*, *P. niger*  $\times$  *velutinus*, *P. ornatus*, *P. silhouettanus*, *P. kantilali* and *P. oxoniensis*) a variety of colour forms have been recorded. The shell and body patterns are affected by the physiological condition of the animal. Colour changes have been observed in captivity, presumably as a result of dietary changes and ageing effects. The form with the most distinctive changes is *P. ornatus* var. *biornatus* where a consistent lightening of



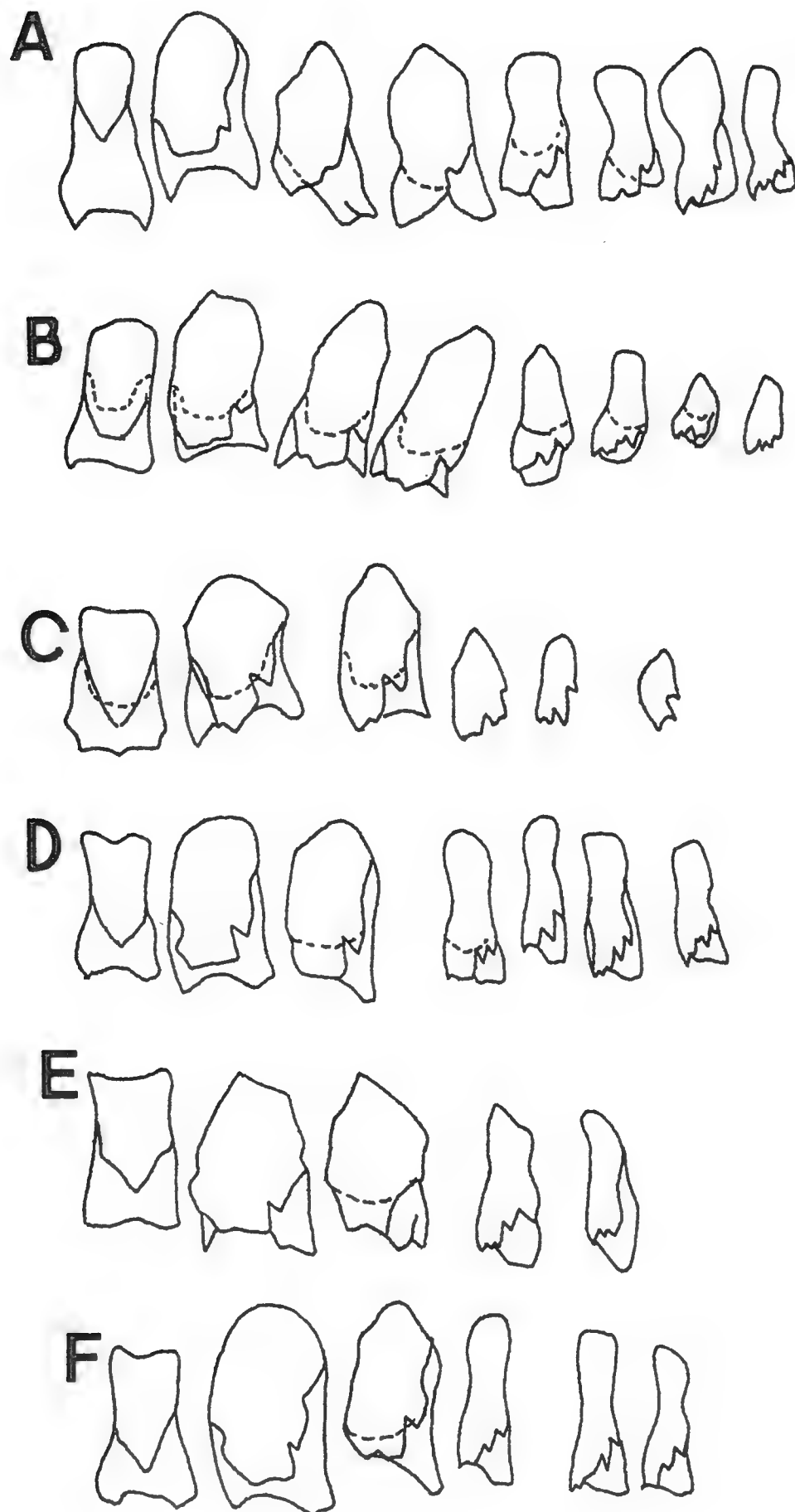


Fig. 5. Radula teeth of (tooth numbers are given after each species): A. *P. praslinus* (C,1,9,11,25,75,110,150) B. *P. silhouettanus* (C,1,8,9,25,75,100,150) C. *P. fregatensis* (C,1,9,25,75,100) D. *P. kantilali* (C,1,9,25,75,100,145) E. *P. ornatus* (C,1,9,25,100) F. *P. oxoniensis* (C,1,9,12,25,100)

the external colouration was recorded. A similar change was recorded in one specimen of the typical *P. ornatus*. These changes take place over a time span of between a week and a month.

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GERLACH: NEW SPECIES OF *PACHNODUS* FROM SEYCHELLES

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# DESCRIPTION OF A NEW SPECIES OF *MARGINELLA* FROM MOZAMBIQUE (GASTROPODA: MARGINELLIDAE)

R. N. KILBURN<sup>1</sup>

(Accepted for publication, May 21st 1994)

*Abstract:* *Marginella (Glabella) rosadoi*, a new species collected in 30 m water-depth off Inhaca Island, is formally described. It is closely allied to *M. (G.) youngi* Kilburn, 1977, from central Mozambique, and, to a lesser extent, *M. (G.) obtusa* Sowerby, 1846, from northern Mozambique and East Africa.

*Key words:* *Marginella*, Mozambique, Inhaca Island

## INTRODUCTION

As far as marine molluscs are concerned, Mozambique remains one of the most poorly studied regions of the Indian Ocean. The following neogastropod from Inhaca Island, off the Bay of Maputo, proves to be undescribed.

## ABBREVIATIONS

a/l = ratio of aperture length (measured along main axis) to total shell length.

l/h = ratio of shell breadth to total length.

MHNM = Museu de Historia Natural, Maputo

NMSA = Natal Museum.

Family MARGINELLIDAE

Genus *Marginella* Lamarck, 1799

*Marginella (Glabella) rosadoi* n. sp.

Figs. 1–2

*Diagnosis:* Shell ovate-conical, ratio breadth/total length 0.63–0.65, length of aperture/total length about 0.79–0.84; last whorl with roundedly sloping shoulder, spire shallowly coeloconoid, whorls not shouldered; sculptured by low but distinct axial ribs, 13–15 on last whorl; labrum very thick, usually with up to about 14 weak, irregular denticles, rarely obsolete, columella pleats 4; siphonal notch slight but distinct; ground colour very pale greyish-yellow with spiral rows of small dark brownish-grey spots and rectangles, terminating on back of lip, apex buff or pale orange. Length 7.4–8.1 mm.

*Description:* Shell ovate-conical, ratios breadth/total length 0.63–0.65, length of aperture/total 0.79–0.84; teleoconch whorls numbering about 2.5. Spire shallowly coeloconoid, spire

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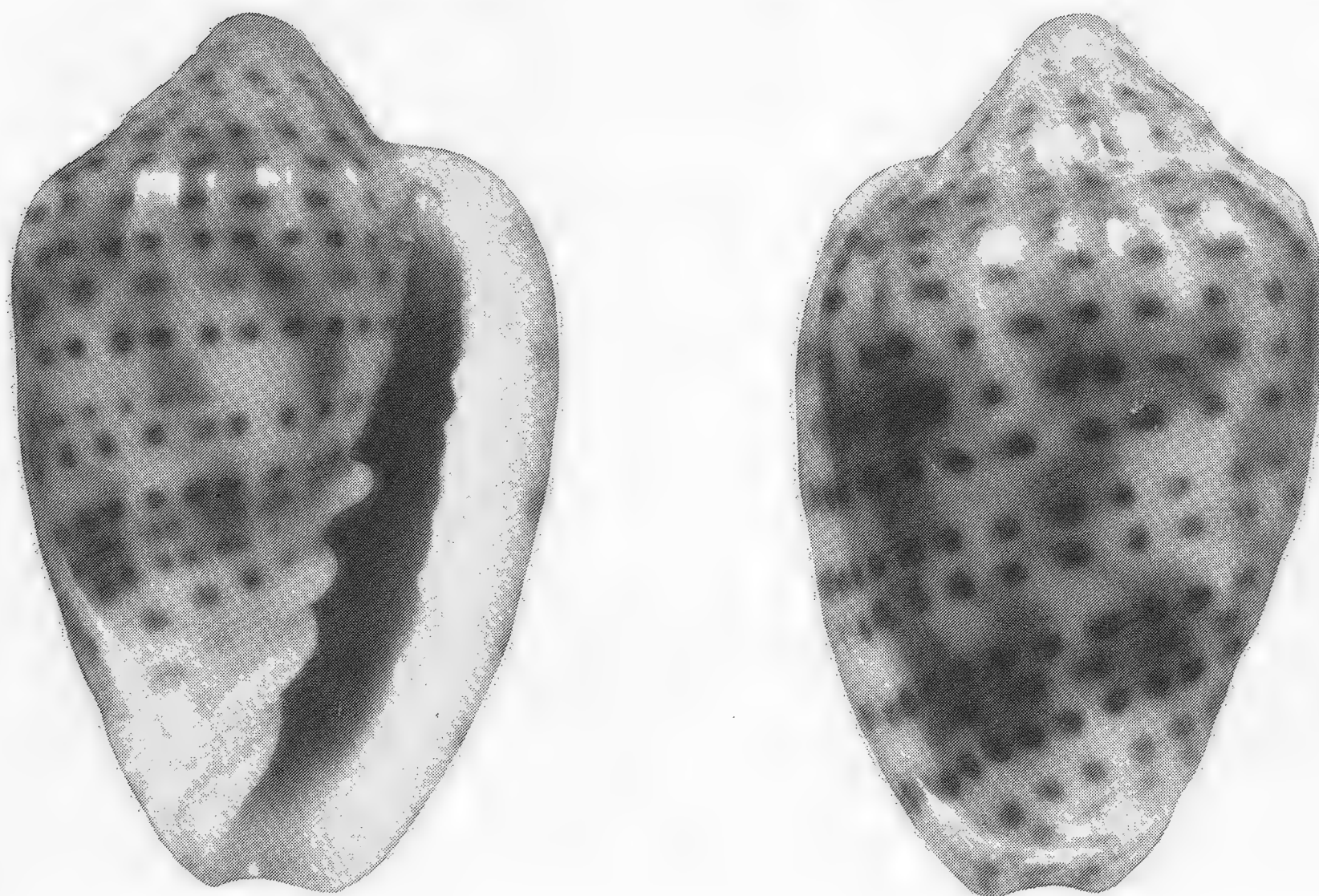


Fig. 1–2. Holotype of *Marginella (Glabella) rosadoi* n. sp. Dimensions  $8.1 \times 5.2$  mm.

whorls flattened to slightly convex below midwhorl; body whorl with rather weak, roundedly sloping shoulder, stronger on outer lip, and slightly concave shoulder slope; sculptured by low, wide-set, rather straight axial riblets, 13–15 on last whorl, becoming obsolete above level of posterior-most columellar pleat; outer lip very thick, its inner edge with up to about 14 weak, irregular denticles, which may be wholly or partially obsolete. Columella with 4 strong pleats, becoming more oblique anteriorly, extending posteriorly 0.61 of total length of inner lip, paries without a callus deposit, aperture narrow, rather linear, termination of siphonal canal very shallowly notched. Protoconch domed, of approximately 1.7 rather vitreous whorls, diameter about 1.1–1.2 mm.

Ground colour very pale greyish-yellow to greyish-white, with widely-spaced spiral series of small, dark brownish-grey spots and spirally elongate rectangles (15–18 rows on body whorl, 2–3 on spire whorls); also present are an underlying series of nebulous, undulating, dark axial blotches, sometimes very faint; labrum whitish, spiral rows of spots terminating on back of lip varix; apex tinged with buff or pale orange.

Dimensions:  $8.1 \times 5.2$  mm (holotype),  $7.4 \times 4.7$  mm (smallest paratype).

*Distribution:* Known only from the type locality.

*Type material:* Holotype NMSA K8502/T857, Inhaca Island, Bay of Maputo, Mozambique, off Lighthouse in 30 m, sand, dredged J. Rosado. Paratypes (same data): 1–3, NMSA L1080/T1169; 4–5, MHNM collection; 6–7, in J. Rosado collection.

*Comparisons:* *Marginella (Glabella) rosadoi* is similar to only three other Indian Ocean species: in size and colour pattern it closely resembles *M. (G.) youngi* Kilburn, 1977, from off Chinde, Mozambique, and in shape and sculpture it is similar to *M. (G.) obtusa* Sowerby, 1846, an East African species whose range reaches northern Mozambique; there is least resemblance to *M. (G.) ansonae* (Clover, 1974) from Madagascar.

In *Marginella youngi* (Kilburn, 1977: 197, figs 25–26) all whorls are strongly shouldered and subsuturally concave, so that the spire is conspicuously stepped and the body whorl distinctly obconical; on the outer lip the shoulder is so prominent as to be almost auriculate.

In contrast, in *M. rosadoi* the shoulder is relatively weak and rounded, and is only developed on the last whorl; the whorls are subsuturally only slightly concave at most, and the shoulder of the outer lip is strongly but evenly rounded. *M. rosadoi* is sculptured by distinct, well-spaced axial ribs, whereas in *M. youngi* the only discernible sculpture is a series of close, feeble axial plicules, faintly and irregularly crenulating the shoulder. Viewed dorsally, the siphonal canal in *rosadoi* shows a slight but distinct notch, absent in *youngi*. The columella pleats extend further posteriorly in *youngi* (occupying 0.71–0.73 of the length of the inner lip, against 0.61 in *rosadoi*), and the outer lip in *youngi* is thicker, with more irregular denticles. In both species the protoconch is similar in size and in its domed profile, but in *youngi* it is colourless and very slightly conical, and apparently consists of about 2 whorls, whereas in *rosadoi* it is tinged with light orange, is evenly domed and appears to comprise about 1.7 whorls. *M. rosadoi* is patterned with dark grey-brown on a greyish-yellow ground, the marks consisting of short, spirally arranged dashes, which continue onto the outer lip. In *M. youngi* the markings are dark grey on a greyish-white ground, the spots more or less chevron-shaped and not continuing (or only irregularly so) into the back of the lip.

*Marginella obtusa* is a much larger species than *M. rosadoi* (length 18–22 mm), has axial ribs that extend onto the base of the body whorl, and the colour pattern is speckled. Although previously recorded only from the Gulf of Aden, the Natal Museum has specimens of *M. obtusa* from the following Mozambican localities: Vamizi (Vamesi) Is., S. of Cabo Delgado (NMSA G86611: A. Jenner); Quirimba Is. (NMSA J8830: E. Roscoe); Nacala (NMSA K3345: K. Grosch).

The types of *Marginella rosadoi* were living in sand, but those of *M. youngi* were trawled on mud (traces of which remain within the aperture in some of the types); *M. obtusa* appears to inhabit coral sand.

The only other ribbed *Marginella* (subgenus *Glabella* Swainson, 1840) known from the south-western Indian Ocean is *M. (G.) ansonae* (Clover, 1974), from Madagascar (although erroneously described from Réunion Island); this differs from *M. rosadoi* in shape, in colour and in possessing axial ribs that extend the length of the body whorl.

*Etymology*: Named in honour of Mr José Rosado of Maputo, discoverer of the species.

#### ACKNOWLEDGEMENTS

This study was supported by a grant from the Foundation for Research Development (FRD). I thank Mr José Rosado of Maputo for his hospitality and for making material available. Mrs Linda Davis helped in the preparation of the plate. Dr D. G. Herbert and Dr B. R. Stuckenberg kindly read the manuscript.

#### REFERENCE

- KILBURN, R. N. 1977. Taxonomic Studies on the Marine Mollusca of Southern Africa and Mozambique. Part 1. *Ann. Natal Mus.* **23**(1): 173–214.





## COMMUNICATIONS

### INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

#### *Applications published in the Bulletin of Zoological Nomenclature*

The following Applications were published on 30 March 1994 in Vol. 51, Part 1 and 30 June 1994 in Vol. 51, Part 2 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

#### Case 2886

***Doris grandiflora* Rapp, 1827 (currently *Dendrodoris grandiflora*; Mollusca, Gastropoda): proposed conservation of the specific name**

Jesús Ortea & Ángel Valdés

*Departamento de Biología de Organismos y Sistemas, Laboratorio de Zoología, Universidad de Oviedo, 33005 Oviedo, Spain*

**Abstract.** The purpose of this application is to conserve the specific name of the Mediterranean nudibranch *Dendrodoris grandiflora* (Rapp, 1827). This species has been widely studied taxonomically and ecologically, and also with regard to some unusual chemical compounds present in it and allied species. The specific name of *Doris guttata*, Risso, 1826 is a senior subjective synonym of *grandiflora*, but it has never been used and its suppression is proposed.

#### Case 2870

***Xerophilla geyeri* Soós, 1926 (currently *Trochoidea geyeri*; Mollusca, Gastropoda): proposed conservation of the specific name**

Edmund Gittenberger

*Nationaal Natuurhistorisch Museum, P.O. Box 9517, NL 2300 RA, Leiden, The Netherlands*

**Abstract.** The purpose of this application is to conserve the specific name of *Trochoidea geyeri* (Soós, 1926) for a terrestrial pulmonate snail (family HYGROMIIDAE) from western Europe, which is also found in Pliocene and Pleistocene deposits. The name is in universal usage but is threatened by five senior subjective synonyms which have been unused since publication and for which suppression is proposed. The earlier names are *Helix arceuthophila* and *H. ycaunica*, both of Mabille (1881); *H. vicianica* Bourguignat in Locard, 1882; *H. deana* and *H. pleurestha*, both of Berthier (1884).

#### *Opinions published in the Bulletin of Zoological Nomenclature*

The following Opinions were published on 30 June 1994 in Vol. 51, Part 2 of the *Bulletin of Zoological Nomenclature*. Copies of these Opinions can be obtained free of charge from the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

OPINION 1765. *Fusus* Helbling, 1779 (Mollusca, Gastropoda): suppressed; and *Fusinus* Rafinesque, 1815 and *Colubraria* Schumacher, 1817: conserved.

OPINION 1766. *Tortaxis* Pilsbry, 1906 and *Allopeas* Baker, 1935 (Mollusca, Gastropoda): conserved by the designation of a neotype for *Achatina erecta* Benson, 1842.

OPINION 1767. *Pleurobranchus forskalii* Rüppell & Leuckart, [1828] and *P. testudinarius* Cantraine, 1835 (Mollusca, Gastropoda): specific names conserved.

OPINION 1768. *Taningia danae* Joubin, 1931 (Mollusca, Cephalopoda): given precedence over *Octopodoteuthis persica* Naef, 1923.

### OXYCHILUS CELLARIUS (MÜLLER) AND OXYCHILUS DRAPARNAUDI (BECK) AS PREDATORS ON EGG-CLUTCHES OF ARION LUSITANICUS MABILLE

Since 1975, the introduced slug *A. lusitanicus* has spread rapidly in Sweden. By the end of 1993 it was known from 379 localities [von Proschwitz, T., *Göteborgs Naturhistoriska Museum, Årstryck* (1989), pp. 43–53 & *Göteborgs*

*Naturhistoriska Museum, Årstryck* (1992), pp. 35–42]. Mass-occurrences have been reported, and the species has become a severe pest in some areas, causing damage to vegetables and ornamental plants in gardens and plant nurseries.

In the Göteborg district (SW Sweden) *A. lusitanicus* now also shows signs of establishing itself in more natural habitats. In Rya skog, a small forest-rest (today completely surrounded by the city of Göteborg), which is part of the original coastal deciduous woodlands in western Sweden, the species was recorded for the first time in 1990. It was probably introduced with dumped garden waste.

When in 1993, I performed a survey of the land snails in the northern parts of the wood, I found *A. lusitanicus* present in high numbers, both in spring and at several later visits in the autumn, in some areas the population density was as high as 5–7 specimens per m<sup>2</sup>. Severe damage to several herbs, caused by snails, could be observed. *Mercurialis perennis*, *Melandrium rubrum*, *Solanum dulcamara*, *Polygonatum multiflorum*, for instance, had been completely defoliated. The slugs even climbed bushes of elm and hazel and ate the leaves.

Numerous egg-clutches of *A. lusitanicus* could be found, some burrowed rather shallowly in the ground or hidden under old stems and branches. Many of them were, however, laying directly on the moist soil under the leaf-litter layer.

On almost every egg-clutch several specimens, in different age stages, of the facultive carnivorous snail *Oxychilus cellarius* were found feeding. *O. cellarius* was found to be one of the most abundant land snails in the northern parts of Rya skog. Probably it had been able to increase its number rapidly, due to the large amount of food present in the form of eggs of *A. lusitanicus*.

To test the ability of *O. cellarius* to consume slug-eggs an adult snail was kept in starvation for five days and then introduced into a terrarium with five egg-clutches containing 15–37 eggs. The total number of eggs was 131. After 13 days the contents of all eggs had been consumed. The egg-shells were, however, only partly eaten, and in some cases left almost intact.

The experiment was repeated with a specimen of a larger species in the same genus – *O. draparnaudi*. This synanthropic species has been introduced in the Göteborg area and is rather common in disturbed habitats (von Proschwitz, T., *Malakol. Abh.* **13** (1988) pp. 143–157). In this case five egg-clutches containing 13–37 eggs were placed in a terrarium into which the snail was introduced. The total number of eggs was 118. After nine days they had been completely consumed by the snail.

It has been pointed out that carabid beetles probably play an important role in the regulation of populations of *A. lusitanicus* as experiments have showed that they consume both eggs and young slugs (Kaiser *et al.* *Endbericht – Untersuchungen über die biologischen und ökologischen Voraussetzungen des Massenaufretens der Spanischen Wegschnecke – Inst. f. Zool., Abt. Morph. u. Ökol., d. Univ. Graz* (1993) 99 pp.). The observations in the field and the results from the simple tests described above indicate that carnivorous snails may also be of importance in this process.

TED VON PROSCHWITZ

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## LAMELLAXIS CLAVULINUS (POTIEZ & MICHAUD) AS A GREENHOUSE SPECIES IN SWEDEN

Several species of the largely tropical family Subulinidae have been spread widely by the help of man, and some have established themselves as greenhouse species in Europe. In N. Europe *Opeas hannensis* (Rang) [= *O. pumilum* (Pfeiffer), *O. goodalli* (Miller)] was found in the tropical hothouse of the park 'Trädgårdsföreningen' in Göteborg, W. Sweden in 1876 (leg: A. W. Malm) and in 1925 (leg: H. Lohmander) [von Proschwitz, T., *Fauna och flora* **78** (1983) pp. 277–284]. The species has also been recorded in the greenhouses of the Botanical Garden of Copenhagen, Denmark, where the only Scandinavian record of the larger species *Subulina octona* (Bruguière) has been made.

A further species, *Lamellaxis clavulinus*, was found in March 1994 in the hothouses of the Botanical Garden in Uppsala, Sweden (leg: K. Martinsson). It has also been recorded from the greenhouse of the Botanical Garden in Helsinki, Finland in 1972 [Valovirta, I., *Kasvitieteellisen puutarhaan eliömaailmaa* **I** (1983) pp. 121–135]. *L. clavulinus* has been recorded in greenhouses in several places in W. Europe (England, Scotland, Ireland, Holland and Germany), sometimes reported under other names [*Opeas mauritanum* (Pfeiffer), *Leptinaria urichi* (Smith)] – [cf. Godan, D. (1979) *Schadschnecken und ihre Bekämpfung*. Ulmer, Stuttgart; Kerney, M. P. & Cameron, R. A. D. (1979) *A field guide to the land snails of Britain and north-west Europe*. Collins, London; Meeuse, A. D. J. & Hubert, B., *Basteria* **13** (1949) pp. 1–30; Pilsbry, H. A. (1946) *Land Mollusca of North America (North of Mexico)*. Monogr. Acad. Nat. Sci. Philadelphia Vol. **II**, Part **1**.]. Further species of *Lamellaxis* have been reported from European greenhouses [e.g. *L. gracilis* (Hutton) from Berlin (Jaekel, S. H. & Plate, H. P., *Z. angew. Zool.* **54** (1967) pp. 361–371)] and it should be noted that the identity of the greenhouse species records and the taxonomy of this wide-spread tropical genus need further studies.

The biology, and especially the reproduction, of *L. clavulinus* (= *O. mauritanus*) has been studied in detail (Schmidt, H. A., *Arch. Moll.* **88** (1959) pp 55–67). Self-fertilization is the predominant mode of reproduction and the



## COMMUNICATIONS

ability of some eggs to hatch immediately after being laid, are probably factors important for the species' ability to spread with the help of man and establishing itself in man-made habitats.

In Uppsala, the snails were first detected in the tropical houses when one plant died and others showed signs of stress. Severe grazing damage was found on the cortex of several plants, especially in the area immediately above and below the soil. A closer examination revealed that *L. clavulinus* was present in the soil in high number and in all age stages. There also seemed to be damage on the root-system of the plants, in which numerous snails were found.

*L. clavulinus* occurred in two of the tropical departments of the hothouses and, in accordance with the high number of specimens, seemed to be well established when it was first detected. It has not been possible to state when the species was introduced or its origin. Plants are regularly imported from several parts of the world, including many Botanical Gardens in Europe. A larger amount of tropical plants, received from Tanzania about a year earlier, was mentioned by the staff as a possible way of introduction.

The snails were controlled with the molluscicide mezurol, which after two weeks had brought down the number, but not eradicated them.

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### *PHASEOLUS GUILONARDI* HOEKSEMA, 1993 IN NORMANDY AND NORTHUMBERLAND

A new species of Phaseolidae, *Phaseolus guilonardi*, was recently described by D. F. Hoeksema (*Basteria*, **57** (1993) pp. 95–102). Both recent and Holocene examples are cited from varied locations along the coasts of The Netherlands and Belgium and from France (off Dunkirk). Very clear photographs of the holotype and paratypes as well as photographs of the rather similar, but distinct, *Phaseolus tumidulus* (Monterosato, 1880) are included in Hoeksema's paper. Specimens are very small, being characteristically 0.40–0.57 mm high and 0.58–0.80 mm long with thin, very oblique taxodont teeth visible under magnification.

The publication of the *Basteria* paper provided the key to the identity of a number of specimens which hitherto I had been unable to identify. I am now able to report eight valves of *P. guilonardi* recovered in June, 1991 from shell sand taken at Portbail in Normandy on the west side of the Cotentin Peninsula: 49°20'N 1°44'W (Sea Area S17F). Two of these valves have been seen by Mr. Hoeksema and confirmed by him as being of *P. guilonardi*. In addition, I have two valves of *P. guilonardi* out of shell sand taken in January, 1993 at Low Newton-by-the-Sea, Northumberland: 55°31'N 1°37'W Map ref. NU 242246 (Sea Area S9). This latter would appear to be the first record of the species in British waters.

Two locations are reported for this species in a subsequent paper (*Basteria*, **58** (1994), p. 69) by T. Keukelaar – Van den Berge & D. F. Hoeksema. The first, like mine, is at Portbail in Normandy; the second is at St. Jacut-de-la Mer in N. Brittany.

I should like to thank Mr. Hoeksema who sent me a reprint of his 1993 paper and a pre-publication text of the 1994 paper and who kindly confirmed my identification of the two specimens.

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# PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

## PROGRAMME SECRETARY'S REPORT

The 1993 programme comprised 7 indoor meetings at the Natural History Museum, 1 at the Linnean Society, 10 field meetings and a molluscan workshop.

We are grateful to the following speakers for giving lectures at indoor meetings: Dr Richard Preece, Dr Elizabeth Harper (University of Cambridge), Mr Fred Woodward, Dr Nathalie Yonow (University of Swansea), Miss Alison Trew (National Museum of Wales), Dr Laurence Cook (University of Manchester) and Ms Jane Reynolds.

In May a joint meeting was held with the Malacological Society of London at the Linnean Society, Piccadilly. The day long meeting entitled *Studies in Mollusca* was held in celebration of the Malacological Society's Centenary. Papers were presented by: Dr David Rollinson (BMNH), Dr Chris Todd (St Andrews University), Dr Georges Dussart (Christ Church, Canterbury), Dr Les Noble (Oxford University), Dr Martin Wells (University of Cambridge), Dr Graham Oliver (National Museum of Wales), Mr John Lucey (Environmental Research Unit, Dublin), Dr Peter Tattersfield (Chapel-en-le-Frith), and Dr Mary Seddon (National Museum of Wales).

Field meetings were held at: Kew, east Oxfordshire, Petworth, Westmorland, Avon Levels, Wicken Fen, Poole Bay, Oban, south Devon and Thatcham. Thanks are due to the following for leading these successful events: Ms Jane Reynolds, Mrs Jan Light, Dr Martin Willing, Dr Barry Colville, Mr Tony Smith, Dr Richard Preece, Dr Shelagh Smith, Mr David Bolton and Ms Rosemary Hill.

The society's ninth Molluscan workshop covering marine and freshwater groups was held at the rooms of the Northampton Natural History Society to whom we extend our thanks.

IAN KILLEEN

## TREASURER'S REPORT

The accounts for the year ended 31 December 1993 show an excess of income over expenditure of £1,840 (1992: £2,589) and a profit after transfer to and from reserves of £1,872 (1992: £1,891).

The fall in the amount of excess income has been caused by the purchase of display boards and a reduction in income from subscriptions, investments and sales. This was partially offset by a fall in publication costs and sundry expenses.

Fees and subscriptions were lower at £11,256 (1992: £12,068) reflecting the continued fall in the number of members and subscribers. Investment income amounted to £2,737 (1992: £3,364) reflecting further falls in interest rates. Sales and donations fell to £936 (1992: £1,413). Thanks are extended to those members who continue to actively sell Society merchandise and back issues of publications.

Publications costs fell by £1,229 to £8,393 (1992: £9,622). The decrease is principally due to the fact that 1992 amount includes costs of preprinting of *Journal Covers* and *Journal* index not incurred in 1993 and a decrease in the print run. Despite a further change in the printer of the Newsletter the costs are lower than 1992 and significantly below costs incurred in years prior to 1992.

Stationery and postage costs were very similar to 1992, the fall in the number of members receiving publications setting off the increase in postage costs.

The Society purchased display boards which form part of a permanent moveable exhibit publicising the Society's activities. The costs of these, £618, are included in sundry expenses and have been set against publicity reserve.

Bank charges for the year amounted to £141 (1992: £180). As of March 1994, the Society's bank have waived charges for current accounts operated by charities.

During the year the Society purchased further shares in the Mersey Docks and Harbour Board following a rights issue by that company. It is anticipated that in the 1994 year part of the Society's cash totalling £17,928 (1992: £16,070) will be invested.

Transfers were made to the Life Members Fund and Reserve and Research Fund from Investment Income. As the Life Members Fund is adequately funded, the transfer to this Reserve was not required, so was transferred back to the Reserve and Research Fund and the income and expenditure account.

No further transfers were made to the Publicity Reserve, however part of this reserve was utilised against the purchase of the display boards and now stands at £182.

## PROCEEDINGS

During the year the position of Membership Secretary was created and took over responsibilities for subscribers from the subscribers secretary and for members subscriptions from the Treasurer.

All members are requested, where possible, to pay subscriptions by standing orders and enter into Deeds of Covenant. Based on current membership levels if all members who are eligible, enter into Deeds of Covenant this would give the Society sufficient additional income to hold membership subscriptions at their current rates for at least the next five years. Standing order forms and Deeds of covenant can be obtained from the Honorary Treasurer or the Membership Secretary.

## RECORDER'S REPORT: MARINE MOLLUSCA

The highlights of the last year result from analysis of marine benthic surveys which has yielded species of molluscs new to the British Marine Sea Area and two new to science.

Samples collected by *R.R.S. Challenger* in 1976 from the Wyville Thomson Ridge, south of the Faeroes are being examined by Ian Killeen and Shelagh Smith. Several deep water and northern species previously unrecorded within our Area have been found including an undescribed *Odostomia* species. However, the most notable is the discovery of the monoplacophoran *Micropilina minuta* Warén. In addition to this representing the first record of this primitive class of molluscs it is apparently the first living record. The species was previously known only from dead shells collected off southeast Iceland.

The faunal analysis of the 1989 and 1991 National Museum of Wales Irish Sea Survey is now complete. Amongst much new data are an undescribed species of Solenogastre and the first records of another, *Macellomenia palifera*, from outside the Mediterranean.

Society field meetings continue to provide a focus for marine recording activities. Last year meetings centred on Oban, west Scotland and at Salcombe, south Devon were highly successful and resulted in much new and updated information. The Oban meeting also gave members an opportunity to collect sub-littoral material from the Firth of Lorne. The Society also organised a dredging trip out of Poole Harbour and although this is a relatively well known area, such work continues to yield new Area records in addition to new data for the Channel Atlas.

Some Areas are more recorded than others and I am encouraged by the number of Sea Areas which are now being recorded on the 2' lat. by 2' long. grid: S3, 9, 11–16 inclusive, 21–26. Maps with coarser units have been prepared for Ireland, West Scotland and the English Channel. All of these projects continue to supply new data into the Census. I have recently produced a revised and updated edition of the marine molluscs of Wight (S15). I am hoping that much of the recording effort in southern England will now be directed towards providing data for a marine mollusc atlas of the Channel. I would like to encourage Members to record in this area, particularly the south coasts of Devon and Cornwall but also in northern France.

Liaison with other organisations has again been a very valuable source of data. MAFF have provided access to material or permitted participation in their surveys in East Anglia and the English Channel.

I am grateful to all Members of the Society who have submitted records this year and also personnel from MAFF Lowestoft and the Dunstaffnage Marine Laboratory for their valuable co-operation.

JANICE M. LIGHT

## RECORDER'S REPORT: NON-MARINE MOLLUSCA

Some apology is due to members for the fact that the new *Atlas* has still not appeared. The text is with the publisher (Harley Books) and a subsidy towards printing costs secured from the Royal Society, but publication remains dependent on the necessary computer-generated maps being made available. I am informed by the head of the Biological Records Centre at Monks Wood (Institute of Terrestrial Ecology) that map production from our data should begin there shortly.

The following new vice-comital records have been verified since the last Report (*J. Conch., Lond.* **34**, p. 400). Unless stated otherwise, all date from 1993–4.

Cornwall East (2): *Toltecia pusilla*, Mount Edgcumbe (20/4553; garden); *Hygromia cinctella*, Polperro (20/2051), both D. E. Bolton.

Somerset North (6): *Toltecia pusilla*, Bristol Botanic Gardens (31/5572), D. E. Bolton.

Kent West (16): *Limax valentianus*, Belvedere (51/4979; garden), D.G. Guntrip; *Dreissena polymorpha*, Sevenoaks (51/5257), Caroline Sutton.

Essex South (18): *Perforatella rubiginosa*, R. Roding, Barking (51/4384), A. Norris.

Berks (22): *Phenacolimax major*, Thatcham (41/5165), Rosemary Hill, 1992.

Oxford (23): *Arion lusitanicus*, Ambrosden (42/6019); *Arion flagellus*, Charlbury (42/3519); *Limax valentianus*, Oxford (42/5406; garden centre), all S. J. Gregory.



Cambridge (29): *Pseudanodonta complanata*, Wicken Fen (52/5570), D. Aldridge.  
 Gloucester East (33): *Limax valentianus*, Cheltenham (32/9723; garden), D. C. Long.  
 Carmarthen (44): *Bathyomphalus contortus* (old shell), *Theba pisana*, Pembrey (22/4300), P. T. Wimbleton.  
 Anglesey (52): *Pomatias elegans*, Bryn Offa, Pentrellwyn (23/5781), K. N. A. Alexander.  
 Lancs South (59): *Toltecia pusilla*, Worsley (34/7300; garden centre), G. Musker.  
 Haddington (82): *Deroceras caruanae*, Dunbar (36/6877), A. T. Sumner.  
 Fife (85): *Milax sowerbyi*, *Milax budapestensis*, *Deroceras caruanae*, Burntisland (36/2286), A. T. Sumner.  
 Perth Mid (88): *Bithynia tentaculata*, Strathallen School Pond (37/0918), T. Huxley.  
 Easternness (96): *Vertigo modesta*, Coire Garbhach, Glen Feshie (27/8894), R. W. Marriott.  
 Shetland (112): *Carychium minimum*, *Columella aspera*, *Vertigo substriata*, *Euconulus alderi*, Tingwall Loch (HU4143);  
*Carychium tridentatum*, Okraquoy (HU4331); *Euconulus fulvus*, Channerwick (HU4024); *Discus rotundatus*, Weisdale  
 (HU3952); *Aegopinella pura*, South Whiteness (HU3844), all R. Tallack.  
 Sligo (H28): *Vertigo geyeri*, Lough Tait (G3915); *Boettgerilla pallens*, Templeboy (G4732), both M. Cawley.  
 Leitrim (H29): *Zonitoides excavatus*, Baloor (G7554), M. Cawley.

Several of the above deserve comment.

Easily the most important discovery of the year is of a second locality in the Grampian mountains for the arctic snail *Vertigo modesta*. Like the first site at Geal Charn in West Inverness-shire (*J. Conch., Lond.* **33** (1988) p. 51) the habitat is among dwarf arctic-alpine willows at a high elevation (c. 800m). Other noteworthy finds among land snails include *Perforatella rubiginosa* from a tidal riverside marsh in south Essex – a welcome addition to the handful of known sites, all alongside the Thames or its tributaries. *Toltecia pusilla* has been detected in three more vice-counties; this enigmatic, probably introduced species, first recognised in Britain only in 1985, is evidently well established in many places in gardens, waste ground and similar habitats. Among other introduced species, *Hygromia cinctella* in Cornwall and *Theba pisana* in Carmarthen must be noted; at Pembrey the latter species is abundant on the coastal sand-hills, roughly half way between well-known sites of similar type on the Pembrokeshire and Glamorgan coasts. *Pomatias elegans* has, somewhat unexpectedly, been found on Anglesey, in limestone grassland some 17kms west of its outpost on Great Ormes Head, Caernarvon. Lastly, the rare *Vertigo geyeri* has been found in a marsh in Co. Sligo, well to the north of the belt of scattered stations long known across the midland counties of Ireland.

Among slugs, *Limax valentianus* can be added for three more vice-counties. Once thought to be exclusively a greenhouse species in the British Isles, evidently it is not uncommon also in open habitats in gardens, nurseries and such-like sheltered places. It is likely to be spreading.

Among freshwater species, the most noteworthy find is of *Bithynia tentaculata* in a large pond in Perthshire, some way outside its main stronghold in Scotland in the canal system of the midland valley. *Dreissena polymorpha* in a flooded gravel pit lake near Sevenoaks in Kent and *Pseudanodonta complanata* from Wicken Fen in Cambridgeshire are also of interest.

Finally, I am specially indebted to Roger Tallack, whose systematic recording of Shetland molluscs over the past year has significantly increased the number of species known for the islands. *Discus rotundatus* and *Aegopinella pura* confirm unsatisfactory, unlocalised Census records for v.c. 112.

M. P. KERNEY

## REPORT OF THE HON. CONSERVATION OFFICER

*The Biodiversity Challenge:* The independent conservation organisations launched this major initiative in December 1993. The Biodiversity Challenge is intended to provide government with measurable species and habitat targets to maintain Britain's biodiversity. The Conservation Officer was involved in the consultation stages of this publication. The challenge includes 32 molluscan targets, many of which are also included in habitat management targets.

*The proposed use of nematode worms as a biological control measure for the removal of slugs:* I have undertaken extensive correspondence regarding this matter. The Society is now reasonably satisfied that such control measures do not pose any significant threats to native species. The development team at Long Ashton Research Station have sent detailed information and have invited the Conchological Society to discuss any further concerns.

*Work with English Nature:*

- *Suggestions for changes/additions to Schedule 5 of The Wildlife & Countryside Act.* Work is currently underway to give suggestions to English Nature in advance of the 1997 Quinquennial Review.
- *Species Recovery Programme.* Discussions are taking place to target particular species for action.
- *EC Habitats and Species Directive.* The Society is involved with work advising on and surveying sites that contain *Vertigo* species.

## PROCEEDINGS

Membership of the Joint Committee for the Conservation of British Invertebrates: Membership has allowed links with a wide range of independent and governmental conservation organisations. A project is being set up to assess the status of *Helicella itala* throughout Britain.

### *Advice given:*

- Oxford City Council have been given wide ranging advice as well as being offered help with their Nature Conservation Strategy.
- The London Wildlife Trust were given advice and help with regard to a *Balea biplicata* site threatened by developers.
- Following joint action with English Nature and West Sussex County Council an important wetland site was saved from being planted with poplars on the strength of its molluscan fauna.
- English Nature was given advice regarding the siting of pheasant release pens in an SSSI, noted for Mollusca.

### *Events attended:*

- The launch of The Biodiversity Challenge.
- Meetings of The JCCBI.
- The launch of The Sussex Downs Conservation Boards management planning process.

### *On-going initiatives:*

- Discussions are underway with the R.S.P.B. to undertake molluscan surveys of their reserves throughout the U.K.
- The British Wildlife magazine has offered the CSGBI a biannual entry in the reports section.

### *Publications received:*

- Habitat.
- various JNCC and English Nature publications
- The Captive Breeding Group News

M. J. WILLING

**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND  
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1993**

**INCOME AND EXPENDITURE ACCOUNT**

	31.12.93 £	31.12.92 £
<b>INCOME</b>		
Fees and subscriptions	11,256	12,068
Investment Income	2,736	3,364
Sales/Donations	936	1,413
	<u>14,928</u>	<u>16,845</u>
<b>EXPENDITURE</b>		
Publication costs	8,393	9,622
Stationery and postage	2,213	2,297
Meetings	830	525
Sundry	1,652	1,812
	<u>(13,088)</u>	<u>(14,256)</u>
<b>Excess of income over expenditure</b>	<u>1,840</u>	<u>2,589</u>
Transfer from publicity reserve	618	—
Transfer (to)/from Reserves:		
Reserve and Research fund	(493)	(577)
Life Members' Fund	(434)	(585)
Life Members' Fund	341	464
<b>Profit for the year</b>	<u><u>1,872</u></u>	<u><u>1,891</u></u>



PROCEEDINGS

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND  
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1993

BALANCE SHEET

	31.12.93 £	31.12.92 £
<b>ASSETS</b>		
Investments	17,372	16,963
Cash	17,928	16,070
Debtors	1,263	1,325
	<u>36,563</u>	<u>34,358</u>
<b>LIABILITIES</b>		
Creditors and accrued charges	4,686	2,863
Advance subscriptions	109	1,567
Life members fund	4,614	4,614
Reserve and research fund	5,838	5,252
Publicity reserve	182	800
	<u>15,429</u>	<u>15,096</u>
	<u>21,134</u>	<u>19,262</u>
Represented by:		
Capital account brought forward	19,262	17,371
Profit for the year	1,872	1,891
	<u>21,134</u>	<u>19,262</u>

A. D. SECCOMBE ACA  
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## INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

**PAPERS** Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

**COMMUNICATIONS** These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

# Journal of Conchology

Vol. 35, Part 2, December 1994

## Contents

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	PAGE
PAPERS	
JUNE E. CHATFIELD—Shell collections in the Maidstone Museum: 1. The collection of Julius Brenchley .. .. .	91
S. GOFAS AND F. FERNANDES—The Marginellidae of Angola: The Genus <i>Marginella</i> .. .. .	103
R. G. MOOLENBEEK AND S. P. DANCE— <i>Anachis donnae</i> (Gastropoda: Columbellidae) a New Columbellid Species from Masirah Island, Oman ..	121
D. G. HERBERT—A note on <i>Peristernia zealandica</i> (Kobelt in Küster & Kobelt, 1876) (Gastropoda: Fasciolariidae) .. .. .	125
P. BOUCHET AND R. HOUART—A New Coralliophilid-Like Muricid (Gastropoda: Muricidae) from the Coral Sea .. .. .	131
R. S. ABSALÃO—A New Species of the Genus <i>Caecum</i> (Prosobranchia: Mesogastropoda) from Southern Brazil .. .. .	137
N. YONOW—A New Species and a New Record of <i>Chelidonura</i> from the Red Sea (Cephalaspidea: Aglajidae) .. .. .	141
M. B. SEDDON, A. J. N. W. PRAG AND J. THORN—Fossil Land Snails from a Hellenistic Archaeological Site in Libya .. .. .	149
O. GRIFFITHS—A Review of the Land Snails of Rodrigues Island (Indian Ocean) with Notes on their Status .. .. .	157
J. GERLACH—New Species of <i>Pachnodus</i> (Gastropoda: Enidae) from Seychelles	167
R. N. KILBURN—Description of a New Species of <i>Marginella</i> from Mozambique (Gastropoda: Marginellidae) .. .. .	179
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE .. .. .	183
T. VON PROSCHWITZ— <i>Oxychilus cellarius</i> (Müller) and <i>Oxychilus draparnaudi</i> (Beck) as Predators on Egg-Clutches of <i>Arion lusitanicus</i> Mabille ..	183
T. VON PROSCHWITZ— <i>Lamellaxis clavulinus</i> (Potiez & Michaud) as a Greenhouse Species in Sweden .. .. .	184
J. E. PHORSON— <i>Phaseolus guilonardi</i> Hoeksema, 1993 in Normandy and Northumberland .. .. .	185
PROCEEDINGS .. .. .	186



# Journal of Conchology

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**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN  
AND IRELAND**

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*The Conchologists' Newsletter* (quarterly).

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COVER DESIGN: *Muricanthus nigratus* (Phillippi) by D. G. Reid.

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**NOTICE**

**Payment by Overseas Members**

Overseas members are reminded that all monies due to the Society are payable in sterling.

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# THE IDENTITY OF *MELANELLA DUFRESNII* BOWDICH, 1822, AND OTHER SPECIES OF EULIMIDAE (GASTROPODA: PROSOBRANCHIA) DESCRIBED EARLIER

D. HEPPELL<sup>1</sup>

(Accepted for publication, November 20th 1994)

**Abstract:** The type species of *Melanella* Bowdich, 1822, is *M. dufresnii*. The identity of this species has been conjectural, and hence the attribution of species to this genus has been uncertain. All earlier described species currently assigned to the Eulimidae are considered, in order to establish that *M. dufresnii* is the valid name for the species often identified as *Eulima arcuata* Sowerby. The taxonomic history of *Melanella* and *Eulima* is discussed in relation to other European Eulimidae, and the synonymy and typification is brought up to date from recent rulings of the ICZN and work published since Warén's (1984) revision of eulimid genera.

**Key words:** Eulimidae, *Melanella*, historical taxonomy, species synonymy

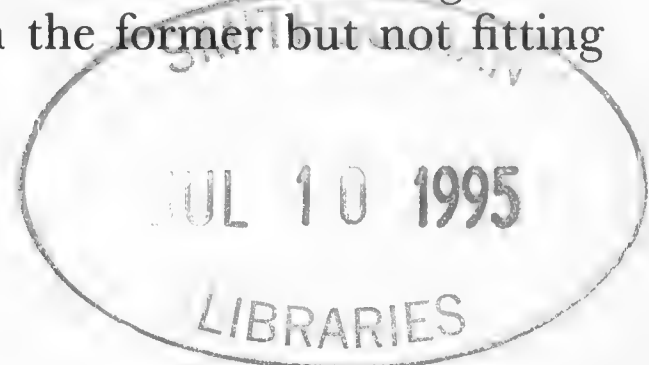
## INTRODUCTION

In deep water, the Eulimidae probably exceed even the Turridae in numbers of species, but are still poorly known. Eulimids are almost always parasitic on echinoderms, but the hosts of most species have not yet been discovered, as they are not permanently attached and parasitize the host only for limited periods. Typically, the shell is white, elongated, highly polished, and often with a curvature (in one plane) or flexure (in more than one plane) of the spire. Growth of the shell is discontinuous, a short phase of rapid growth alternating with a longer phase of no growth, but it has not been established whether these growth phases correlate with the periods of parasitization. At the end of the rapid growth phase, the outer lip of the shell is thickened. In adult shells, its successive positions are marked by a series of impressed scars, curved according to the shape of the lip. These correspond to the varices of many other gastropod genera, and have often been called by that term, but, as they are not raised above the surface of the shell, the term 'incremental scars', as used by Warén (1984), is used here instead. The regularity of these scars, and their frequency (usually every 0.3 to 1.5 whorls), is an important taxonomic character. In species with a marked curvature or flexure of the spire, the incremental scars tend to occur only on the inside of the concavity. Generally the sexes are separate, with some sexual dimorphism of the shell; males are about 30% smaller than females, and are more slender with flatter whorls (Bouchet & Warén 1986).

## HISTORY OF EULIMID CLASSIFICATION

In the eighteenth century the few eulimid species which had been named were assigned to the Linnaean genera *Turbo* and *Helix*, usually being placed in the former but not fitting

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comfortably in either. Da Costa (1778) included them in his genus *Strombiformis*, a name derived from the term 'Cochleæ strombiformes' introduced in his non-binominal *Elements of Conchology* two years earlier. This heterogeneous group of gastropods, characterized by a long, slender shell with a sharp apex, was not adopted by most other workers and the generic name *Strombiformis* was largely ignored.

In Britain there was great reluctance to modify the Linnaean classification of molluscs. Johnston (1850), in his *Introduction to Conchology*, expressed considerable contempt for this unscientific conservatism when he wrote: '... nothing was tolerated that was not according to the letter of Linnæus... the slightest attempt to alter this order was treated as an attempt to replunge us into the chaos whence he had brought us, and further improvement or alteration was declared to be futile...'. In France, however, regard for the Linnaean system was less slavish, and the new genera introduced by Bruguière and Lamarck at the end of the eighteenth century were widely accepted. Lamarck established several genera of freshwater gastropods, including *Melania*, the type genus of his family group 'les mélaniens' [now *Thiara* and *Thiaridae* respectively]. No fault was found with the recent species included by Lamarck in that genus but, as Fischer (1887) pointed out, he was less discerning in his allocation of fossil shells. Among the dozen ill-assorted fossils included by Lamarck in *Melania*, not one of which was correctly assigned to that genus, there was, significantly, a species of eulimid. Lamarck also erred in presuming a closer relationship between the freshwater prosobranchs and pulmonates than between the siphonate and asiphonate prosobranchs.

In most of Europe, the reverence shown to Lamarck was equal to that accorded to Linnaeus in Britain, with the consequence that later continental workers continued to place a variety of unrelated fossils, including eulimids, in *Melania*, if they showed some resemblance to the supposed Tertiary melaniids of the Paris Basin. Bowdich (1822), an English naturalist, made the first attempt to subdivide *Melania*, but of the six subgenera published in his *Elements of Conchology* in 1822, only *Melanella* concerns us here. Bowdich prepared this work in Paris, where he was given unrestricted access to specimens for illustration: 'apart from non-marine species copied from Férussac, almost all the other figures of the recent, and some few of the fossil shells, have been drawn from the objects themselves; which I have invariably been permitted to take home from the Museum for that purpose, without being limited either to time or number'. In addition to those in the museum, he was also able to borrow additional specimens from the private cabinets of Lamarck and Dufresne. Among those from the latter collection was the species *Melanella dufresnii*. The identity of that species is the main subject of this paper, and will be discussed below.

At first sight of Bowdich's (1822) work, it seems as if he anticipated the new classification of Mollusca published by Blainville (1825) in his *Manuel de Malacologie et de Conchyliologie*, but Johnston (1850) pointed out that Blainville's system 'appears to have been invented in 1816, but by a curious accident it was not published until 1825'. Apparently it had been written for inclusion in 'a British Encyclopædia' but had been mislaid by Leach and lost for several years. In Paris, Bowdich must have been aware of the progress of the new classification, as he included *Melania* in a subdivision of the Ellipsostomata, a group which still contained a mixture of prosobranch and pulmonate genera with an elongated spire and a relatively large body whorl with an entire, elliptical aperture. By 1825, Blainville had redefined the Ellipsostomata to exclude the hermaphrodite, non-operculate pulmonates, although the only eulimid figured in the *Manuel* was assigned not to *Melania* but to *Phasianella*.

In 1826 Risso established the genus *Eulima*, still within Blainville's Ellipsostomata, for several small species found living or fossil in the neighbourhood of Nice. Although he was justified in assigning them to a new genus, Risso was negligent in not comparing them with species already known. Other workers, however, soon transferred various species from

*Turbo*, *Helix*, *Melania* and *Phasianella* into *Eulima*, but there was no consensus on the relationships of the new genus. At first it was left in the Melaniidae, despite some opinions which placed it closer to *Phasianella*, *Turritella*, *Epitonium* or even *Viviparus*. In the same work, Risso had also introduced the eulimid genus *Niso* but, as he had placed it among turrid genera, it remained unrecognized for many years.

Gray proposed a substantial reclassification of the Gastropoda in several editions of the *Synopsis of the Contents of the British Museum*, published between 1840 and 1844 and revised in 1847. A new suborder, the Eriophthalma, was introduced, accommodating those old ellipsostome families with sessile eyes at the base of the tentacles. Although many new small families, including the Pyramidellidae, were recognized within this group, *Eulima* and *Nisso* [sic] were at first retained within a much enlarged family which included not only *Melania* but also *Cerithium* and *Littorina*. In the course of this revision, however, the Pyramidellidae was later split off, with the Truncatellidae and Acteonidae, to form a further subgroup, the Iniophthalma. At the same time, *Eulima*, *Niso* and *Balcis* (based on a Leach manuscript name) were finally moved out of the Melaniidae and placed in the Pyramidellidae. Subsequent revisions by Gray (1853, 1857), subdivided his Iniophthalma on the basis of radular characters, following the pioneering work of Lovén (1847) and Troschel in Wiegmann & Ruthe (1848). The Pyramidellidae were placed in the Gymnoglossa, a new group characterized by the radula being rudimentary or absent. By 1857 the twelve genera assigned by Gray to this family included three more now regarded as eulimid: *Leiostraca* Adams & Adams, 1853, *Stylina* Fleming, 1828 (non Lamarck, 1816) and the endoparasitic *Entoconcha* Müller, 1852. Some of the families originally included in the Gymnoglossa, such as the Architectonicidae, were later found to possess a radula, and were transferred elsewhere. By the time Mörch (1867) reviewed the radula-based classification of the Mollusca, the Gymnoglossa contained only the Pyramidellidae, which at that time included the eulimids, and Mörch doubted whether the absence of the radula was a significant character for delimiting a taxonomic group.

The Pyramidellidae was established by Gray (1840) for genera 'known by the oblique plaits on the front of the pillar lip of the polished spotted, turreted shell, and by their tentacles being broad and folded like the ears of a hare', so it is somewhat surprising that the eulimids, with no columellar plaits, no spots, and tentacles as often round or flat as folded, should find a home there. Orbigny established a separate family for the Pyramidellidae at about the same time as and perhaps independently of Gray.<sup>2</sup> His Pyramidellidae, as in Gray's later revisions, included *Eulima*. Orbigny knew that *Pyramidella* was a monoecious hermaphrodite, and on that account he subsequently assigned the family to Blainville's suborder Monoica. Incredibly, Orbigny (1841) also placed here the family Littorinidae, a family in which the sexes are quite separate; not surprisingly, he commented on the unnaturalness of this classification.

By the middle of the nineteenth century, the parasitic habits of some pyramidellids was known but the association between eulimids and echinoderms had only begun to be suspected, with Turton's (1825) observation of his *Pelseneeria stylifera* living on the spines of a sea-urchin and Broderip's (1832) discovery of his *Stilifer astericola* embedded in a starfish. Some species of *Melanella* had been found in holothurians but, although some workers on echinoderms had stated this relationship to be parasitic, Jeffreys (1864) probably expressed the views of most contemporary malacologists when he stated, of Turton's species, that 'my impression is that it feeds on the excretions of Echinoderms', and that Orbigny's conjecture

<sup>2</sup> The priority of the name Pyramidellidae was determined by ICZN Direction 54 (1956). It was accepted as having been first published by Gray because he gave a proper diagnosis, which Orbigny did not, and Gray's work is known to have been published in 1840, whereas the relevant portion of Orbigny's *Voyage dans l'Amérique méridionale* may not have been published until 1841. (*Opin. Decl. int. Commn zool. Nom.* 12 (26)).

that *Eulima* might be parasitic, like *Stilifer*, had no foundation. Jeffreys admitted that species of *Eulima* had been found in the stomachs of holothurians but, he believed, 'this is not a case of parasitism: the *Eulima* feeds the Holothuria, instead of feeding upon it'. Thus, when Adams & Adams (1853) placed the families Eulimidae and Styliferidae next to their Pyramidellidae, the parasitic nature of their Eulimidae was still unsuspected.

The association of the Eulimidae with the Pyramidellidae in the same higher taxon (variously known as the Gymnoglossa, Aglossa or Pyramidellacea) was a long one, despite some obvious anatomical and developmental differences. They were not separated until Fretter & Graham (1949) removed the Pyramidellidae to the Opisthobranchia, leaving the Eulimidae with the Aclididae and Styliferidae in the restricted superfamily Eulimacea. Subsequently the Pyramidellidae were placed with some other families in a separate subclass of the Gastropoda, the Heterobranchia, as being neither prosobranchs nor opisthobranchs. Graham (1988) mistakenly also included the Eulimidae within this subclass, but they remain true prosobranchs.

Grusov (1965) reviewed the relationships of the endoparasitic genus *Asterophila* to other parasitic gastropods, and concluded that there were insufficient characters to warrant its retention in a separate family, the Asterophilidae, and moreover that all the 'eulimid' families should be united into a single broad family, which he called the Melanellidae. This higher classification was confirmed by Warén (1984), who similarly combined the Stiliferidae, Pelseneeriidae, and the endoparasitic families Entoconchidae, Enteroxenidae and Asterophilidae with the Eulimidae, provisionally accepting only the Aclididae as a separate family within the superfamily Eulimoidea (= Eulimacea).

#### TAXA OF THE SPECIES GROUP

Early specific names, in any group, may not have been correctly assigned to the genus or even family in which they were originally placed. When evaluating their status it is convenient to consider them in chronological order, to determine whether each nominal species is valid, or a synonym or homonym of an earlier or contemporaneous taxon, or a nomen dubium. Varying usage of the names by different authors must be considered and, ideally, should lead to a correct historical synonymy for each species. The task is complicated by the absence of type material, and in some cases new species were described not from specimens but from earlier accounts and illustrations. Furthermore, the early descriptions and figures may be inadequate and fail to distinguish the new taxon from those described previously. Eighteenth-century workers relied heavily on citations of previously published work to document and characterize their new species, but the cited synonyms and references to earlier figures may themselves be ambiguous. In such difficult groups as the Eulimacea, the importance of identifying holotypes and selecting lectotypes and neotypes is clear, for only such material can unambiguously fix a specific name to the species typified by those specimens.

The species-group taxa of the Eulimacea published up to and including *Melanella dufresnii* are, therefore, here considered in order of publication. Not only does this reveal that *M. dufresnii* is not a synonym of an earlier described species, but it provides a useful summary of our present knowledge of these early taxa. In this section a colon (:) is used before an author's name to distinguish subsequent misidentifications and new generic placements from original proposals of new species; an alphabetical summary of the synonymy is given at the end.



*Turbo politus* Linnaeus, 1758

*Systema Naturae*, ed.10, 1: 767, no.570.

Description: T[urbo] testa turrita imperforata glaberrima, apertura ovata. Habitat in M. Mediterraneo. Testa gr[ani] hordei magnitudine, albissima, opaca nec pellucida, nitidissima, anfractibus linea excavata tenui interstinctis.

This was the last species included by Linnaeus in 1758 in his genus *Turbo*; there were no references given to earlier descriptions or illustrations, and the description was repeated without significant change in the later editions of the *Systema Naturae*. Hanley (1855) discussed the identity of this species, noting that the name *Turbo politus* had generally been applied to the eulimid species '*Turbo albus* of Donovan' [= *Strombiformis albus* da Costa, 1778], and that 'in default of a rival with more valid pretensions, the decision of the majority may be followed'. He pointed out, however, that the size specified by Linnaeus, 'grani hordei magnitudine' [the size of a grain of barley, i.e. 6–8mm], is smaller than normal for that species [15–20mm]. Nevertheless, the name *Eulima polita* (Linnaeus) was applied to da Costa's species, at least by British authors, until well into the twentieth century.

Dautzenberg (1927) drew attention to an overlooked work by Martel (1905) which challenged the traditional interpretation of *Turbo politus* Linnaeus, and reserved that name for a Mediterranean species smaller than and distinct from the one familiar to British workers. Consequently, Winckworth (1932), in his revision of the British marine Mollusca, substituted *alba* for *polita*, assigning the species to the genus *Balcis*. Martel did not indicate which other nominal species might be synonymous with his concept of *Turbo politus*, nor was this species included by Dodge (1959) in his partial review of the Linnaean species of *Turbo*. Different authors continued to use the name in different senses, and there was no consensus until Warén (1988) made a thorough evaluation of all possible interpretations and concluded that Linnaeus's name should be applied in the sense of *Eulima intermedia* Cantraine, 1835, and its synonym *Rissoa sinuosa* Scacchi, 1836.

It was not possible to solve the identity of *Turbo politus* simply by reference to type material. Hanley (1855) referred to manuscript evidence in the Linnaean copy of the tenth edition of the *Systema Naturae* that Linnaeus had possessed a specimen, but there was no corresponding annotation in the twelfth edition. The only eulimid shells present in the Linnaean collection had certainly been added after Linnaeus's death; Hanley had earlier noted 'the presence in the collection of a wretched example of *E. polita* . . ., but I have failed in detecting it in a more recent examination'. Dance (1967) included *Turbo politus* in his 'List of Linnaean species not represented by specimens in the Linnaean collection'. In the belief that no type material was available, Warén (1988) chose a specimen from Tunisia, now in the Zoological Museum, Uppsala, as a neotype. There was similarly no type material extant either for *Eulima intermedia* Cantraine, 1835, or for *Rissoa sinuosa* Scacchi, 1836. In order to remove any further doubt about these taxa, Warén made them objective synonyms by designating the same specimen as the neotype for all three nominal species. He regarded *Acicularia pernula* Monterosato, 1890, and *Eulima intermedia* var. *rubrotincta* Jeffreys, 1867, as additional subjective synonyms.

Subsequent to this designation of a neotype, however, revision of Linnaean material in the collections of the University of Uppsala revealed the existence of several apparently authentic syntypes of *Turbo politus* (Warén & Gittenberger 1993). Unfortunately, these did not confirm Warén's earlier synonymy, as they were specimens of the terrestrial species *Ceciloides acicula* (Müller, 1774), presumably found on the shore after having been washed out to sea. In order to preserve the name *Turbo politus* in the sense of the designated neotype, Warén & Gittenberger (1993) applied to the International Commission on Zoological Nomenclature (ICZN) for this original type material to be set aside for the purposes of

zoological nomenclature. Warén's neotype designation was ratified by the ICZN in Opinion 1780 (1994).

*Eulima intermedia* Cantraine is the type species of *Acicularia* Monterosato, 1884, and *Rissoa sinuosa* Scacchi, 1836, seems to be congeneric with the type species of *Polygireulima* Sacco, 1892. As *Turbo politus*, *Eulima intermedia* and *Rissoa sinuosa* are now all based on the same neotype specimen, the three specific names are objective synonyms. *Polygireulima* is here regarded as a subgenus of *Melanella* Bowdich, 1822. As the name *Acicularia* is preoccupied several times over, the currently valid name for this species is *Melanella (Polygireulima) polita* (Linnaeus, 1758). It is uncommon outside the Mediterranean, but has been found on soft bottoms in 30–150m as far north as Scandinavia. From the British area it has been recorded alive only from the south-west, although there are old records of shells from Shetland, the west of Scotland and the Channel Islands (Fretter & Graham 1982; Seaward 1990). It is probably an intermittent parasite on echinoderms, but its specific host is still unknown.

***Turbo albus* Pennant, 1777**

*British Zoology*, ed.4, 4: 113 (4to ed.) [p.130 (8vo ed.)], no.114; pl.79 [lower figure].

Description: T[urbo] with eight spires, striated transversely; white. About  $\frac{1}{3}$  of an inch long. Found on the shores of Anglesea.

This name was suppressed by the ICZN in Opinion 1739 (1993). For discussion see under *Turbo laevis* below.

***Turbo laevis* Pennant, 1777**

*British Zoology*, ed.4, 4: 113 (4to ed.) [p.130 (8vo ed.)], no.115; pl.79 [upper figure].

Description: T[urbo] with eight smooth spires, nearly obsolete. About  $\frac{1}{3}$  of an inch long. Found on the shores of Anglesea.

This name was suppressed by the ICZN in Opinion 1739 (1993).

The eight small shells which comprise Pennant's plate 79 are not individually numbered but, by elimination, the lower figure of the central group seems to be the one intended for *Turbo albus*, while the upper figure was probably intended for *T. laevis*. The descriptions of both species are minimal, the illustrations are poor, and no type material of either species is known. The transversely striated whorls would seem to eliminate the possibility that Pennant's name *Turbo albus* was based on a eulimid, nor is there much to suggest that family in the case of *T. laevis*. Nevertheless, da Costa (1778) tentatively synonymized these names with his own *Strombiformis albus* and *S. glaber* respectively. Pulteney (1799) placed *T. laevis* as a possible synonym of his *Helix polita*, and this interpretation was followed by Montagu (1803). In the same work, Montagu doubtfully referred *T. albus* Pennant to the synonymy of his *Helix labiosa* [= *Rissoa membranacea* (J. Adams, 1800)]. Donovan (1804) provided excellent figures of da Costa's two species, using the names *Turbo albus* and *T. subulatus*, and continued to mention Pennant's species in their synonymy, although without much conviction.

The consensus of later authors was that *Turbo albus* should be excluded from the Eulimidae, and it was generally assumed that Pennant's description best fitted the pyramidellid *Turbonilla lactea* (Linnaeus). *Turbo laevis*, although assumed to have been a eulimid, was not used as the valid name for any species after its original publication. Those authors who mentioned the name treated it as a possible synonym of *Turbo politus* of authors (non Linnaeus), i.e. *Strombiformis albus* da Costa. Warén (1989) considered that Pennant's illustration of *Turbo albus* might have been based on a specimen of *Aclis minor* (Brown) and that either of Pennant's figures could represent a worn or juvenile specimen of *Bittium reticulatum* (da Costa), *Turritella communis* Risso, or *Rissoa membranacea* (J. Adams). Both names are obviously nomina dubia but, because of their early date, could be interpreted as senior

synonyms of several junior names. *Turbo albus* was not only a possible senior synonym of *Strombiformis glaber* da Costa, but a likely senior secondary homonym of da Costa's *S. albus* as well. As such names are a threat to nomenclatural stability, especially in the event of overlooked type material being rediscovered, Warén (1992b) applied to the ICZN for both names to be suppressed for the purposes of priority but not for the purposes of homonymy. The Commission duly agreed to this action in Opinion 1739 (1993).

***Strombiformis albus* da Costa, 1778**

*Historia Naturalis Testaceorum Britanniae*: 116, no.68.

Although da Costa did not illustrate this species, his description of a 'milk white, smooth, and very glossy, pretty thick, yet semitransparent' shell, with flat whorls only separated by a slight furrow and tapering to a sharp point, is sufficient to identify it. He had probably seen young specimens only, as he mentions eight (rather than 13–17) whorls, and a size 'not half an inch long', instead of the adult height of 20mm or so. The excellent figure by Donovan (1804: pl.177), as *Turbo albus*, no doubt helped with the early recognition of da Costa's species. Donovan must have illustrated a Mediterranean specimen, as he noted: 'We have never met with this shell on any of the British sea coasts, although we are told it is found not very unfrequently on several of those to which our researches have been directed'. As noted above, *Strombiformis albus* was confused in the nineteenth century with *Turbo politus* Linnaeus but, since the correct usage of the latter name was established, da Costa's name has been used consistently for this, the largest of the British Eulimidae.

The original material described by da Costa was from Cornwall and Devon, but this is not thought to be extant. Warén (1989) designated a neotype specimen from Plymouth, Devon, and selected lectotypes for two of its junior subjective synonyms *E. subangulata* Sowerby, 1834 and *E. porcellana* A. Adams, 1851. Syntypes of a further synonym, *E. anglica* Sowerby, 1834, are preserved in the Natural History Museum, London. The specific name *albus* da Costa, 1778, based on the neotype designated by Warén, was placed on the Official List by the ICZN in Opinion 1739 (1993); it is currently assigned to the genus *Melanella*, subgenus *Balcis*. *Melanella (Balcis) alba* is distributed from Norway to the Mediterranean and all round the British Isles from 10–50m, but it is not common. It is an ectoparasite of the holothurian *Neopentadactyla mixta* (Östergren) (Graham 1988).

***Strombiformis glaber* da Costa, 1778**

*Historia Naturalis Testaceorum Britanniae*: 117, no.69.

This is the most easily recognized of all the eulimids described in the eighteenth century. The description of a shell 'very taper and slender, thin and transparent, extremely smooth and glossy, of a light horn colour, with a few spiral streaks, sometimes opaque white, sometimes red' characterizes this species. The stated size, 'about half an inch long', distinguishes it from the smaller and rarer *Eulima bilineata* Alder, the only other British species with coloured spiral bands. Nevertheless it has several junior synonyms and throughout the nineteenth century was known as *Eulima subulata* (Donovan), which is the type species of *Eulima*. *Eulima lineata* Sowerby, 1834, is a junior synonym; *E. lineata* Alder, 1848, was published simultaneously with an additional conditional name, *E. bilineata* Alder, 1848, in case it should prove to be different from Sowerby's species, which it did. *E. glabra* Jeffreys, 1884, a junior homonym, was renamed *E. pseudoglabra* Dautzenberg & Fischer, 1912; it is not a *Eulima* but a *Melanella*.

The original material described by da Costa was from Exmouth, Devon. As there is no extant type material of either *Strombiformis glaber* da Costa or of *Turbo subulatus* Donovan, Warén (1989) chose the same specimen, from south Devon, as the neotype of both species,



thus making the two names objective synonyms. He also noted that a single syntype of *Eulima lineata* Sowerby is preserved in the Swedish Museum of Natural History, Stockholm. *Strombiformis glaber* da Costa is currently assigned to the genus *Eulima*. It is distributed from the British Isles to the Mediterranean, occurring at 10–100m on sandy and muddy bottoms on all British coasts. Its host is unknown but it is probably, like other species of *Eulima*, an ectoparasite of an ophiuroid (Graham 1988).

***Turbo terebellum* Chemnitz, 1788**

*Neues systematisches Conchylien-Cabinet* 10: 302, pl.165, figs.1592–93.

Description: Testa turrita, umbilicata, glabra, flavescens, carinata in unoquoque anfractu.

The first eleven volumes of Martini & Chemnitz's *Neues systematisches Conchylien-Cabinet* were suppressed by the ICZN in Direction 1 (1954)<sup>3</sup> because the work was not consistently binominal. No names have priority from their publication therein but, as the work was much cited because of its extensive descriptions and synonymies and copious illustrations, most of the new names proposed by Martini & Chemnitz were made available when adopted by later authors. Chemnitz described *Turbo terebellum* as a smooth, wax-yellow shell with 14 whorls tapering to a sharp point. It had a sharp keel on the base, surrounding an umbilicus, and was said to have been found on the shores of the Nicobar Islands. From the figure and description the shell is clearly recognizable as a species of *Niso* Risso, 1826, and thus was the first species of this genus of umbilicated eulimids to have been brought to scientific attention. The subsequent history of Chemnitz's name, however, is complicated for three reasons:

1. Chemnitz's very distinctive shell did not fit well into any genus recognized at that time, and consequently was assigned to several different genera by different authors.

2. The specific name '*terebellum*', apparently a diminutive form of the noun '*terebra*' and implying a resemblance to a small boring tool, was emended by various authors to '*terebella*' or '*terebellus*' or to an adjectival form '*terebellata*, -us, -um'.

3. Species of *Niso* are very uniform in general appearance, and Chemnitz's figure was the only illustration available at the beginning of the nineteenth century. For that reason it was cited in connection with the descriptions of some European fossil species of *Niso*, despite the stated Indian Ocean provenance of Chemnitz's specimen.

The taxonomy is further confused by another species, described earlier as *Helix terebella* Müller, 1774,<sup>4</sup> which had a similar history of varying generic placements, emended forms of the specific name, and citation in the synonymy of various European fossils. *Helix terebella* Müller, originally supposed to be a land snail, is now recognized (e.g. by Abbott & Dance 1982) as a distinctive variety of the common Indo-Pacific and Caribbean species *Pyramidella dolabrata* (Linnaeus, 1758). Subsequent taxonomy is best unravelled chronologically; names now referred to pyramidellid species are enclosed in square brackets.

[*Bulimus terebellum* Bruguière, 1792. A new generic placement and emendation of *Helix terebella* Müller, 1774. As an unjustified emendation the name takes its own author and date; it does not preoccupy *Bulimus terebella* C. B. Adams, 1849, a Jamaican species of the oleacinid genus *Spiraxis*.]

*Bulimus terebellatus* Lamarck, June 1804. Lamarck cited the Chemnitz figure of *Turbo terebellum* but used this emended form of the specific name for an Eocene fossil *Niso* from the Paris Basin. This fossil species was subsequently figured in 1806 (*Annls Mus. Hist. nat. Paris*

<sup>3</sup> The Commission had already ruled in Opinion 184 (1944) that no new specific or subspecific names in these volumes had any status in nomenclature.

<sup>4</sup> Müller's species is a senior primary homonym of *Helix terebella* Megerle von Mühlfeld, 1824, which appears to be an Adriatic rissoid.

8: pl.59, fig.6 a,b); the name *Niso terebellatus* (Lamarck) is available for it. Deshayes (1838) made this species the type of a new genus *Bonellia*, but that name is preoccupied in Echiuroida by *Bonellia* Rolando, 1822, and, in any case, Warén (1984) has indicated that *Niso* is such a homogeneous genus that subdivision is unnecessary. *Bulimus terebellatus* Lamarck is also the type species of the genus *Janella* Grateloup, 1838, but the Miocene fossils identified by Grateloup as Lamarck's species were renamed *Niso burdigalensis* Orbigny, 1852. Although the type species of *Janella* was thus misidentified, the generic concept is not affected and *Janella* is another junior synonym of *Niso*.

[*Auricula terebellata* Lamarck, August 1804. Lamarck's description, indicating three plaits at the base of the columella, clearly indicates that this Eocene fossil from the Paris Basin was a species of *Pyramidella*, and this was confirmed when a figure was subsequently published in 1806 (*Annls Mus. Hist. nat. Paris* 8: pl.60, fig.10 a,b). Lamarck's name is available for this species.]

[*Pyramidella terebellum*: G. Fischer, 1807. The first currently accepted generic placement of *Helix terebella* Müller, 1774, but with the specific name as emended by Bruguière.]

*Helix terebellata*: Brocchi, 1814. Brocchi applied this name to an Italian Pliocene fossil which he identified as *Bulimus terebellatus* Lamarck. Although Brocchi's species is undoubtedly a *Niso*, it is not conspecific with that from the Paris Basin. Philippi (1836) treated *Turbo terebellum* Chemnitz, *Bulimus terebellatus* Lamarck and *Helix terebellata* Brocchi as synonyms of *Niso eburnea* Risso, 1826, which name he applied to a Sicilian Tertiary fossil, but subsequently (Philippi 1844) he used the earlier name *N. terebellum* for it. Hörnes (1856) recognized that the Eocene and Neogene fossil species, as well as Chemnitz's Recent species from the Nicobar Islands, were all distinct, and referred Brocchi's Pliocene species and Grateloup's Miocene species (as well as *N. burdigalensis* Orbigny) back to *N. eburnea*. This is the type species of *Niso*, originally described from subfossil material from La Trinité, near Nice. Arnaud (1978) presumed Risso's original type material to be lost, but nevertheless regarded *N. eburnea* as a valid species. No species of *Niso* is known to live in the Mediterranean at the present time. Bouchet & Warén (1986)<sup>5</sup> considered it was impossible to make a certain identification of *N. eburnea* as several species are known which would fit Risso's original description and rough figure. Chemnitz's name was made available by Dillwyn (1817) for the Recent species from the Nicobar Islands and, as Risso's name is a nomen dubium, the earliest name available for the species described by Brocchi and Philippi (and to which Risso's material may well have belonged) is *N. acarinatoconica* Sacco, 1892. This is the only species of *Niso* included in a check-list of Italian Pliocene Mollusca by Caprotti (1976).

[*Turbo terebellatus*: Brocchi, 1814. Brocchi applied this name to an Italian Pliocene fossil which he identified as *Auricula terebellata* Lamarck, although he noted the keel on the base of the last whorl was more obtuse than in Lamarck's figure. The three plaits at the base of the columella show Brocchi's species to be a *Pyramidella*, but it is not conspecific with that from the Paris Basin. Hörnes (1856) and Sacco (1892) referred Brocchi's Pliocene material to *Pyramidella plicosa* Bronn, 1838, together with other Neogene records previously identified with Lamarck's Eocene species.<sup>6</sup>]

[*Trochus terebellus*: Dillwyn, 1817. A new generic placement and emendation of *Helix terebella* Müller, 1774.]

*Turbo terebellum* Dillwyn, 1817. This is the first usage of Chemnitz's name in unemended

<sup>5</sup> Warén (*in litt.*) comments: 'We do not know if this species is Pliocene or Pleistocene'.

<sup>6</sup> According to Glibert (1949), the figure published by Hörnes as representing *P. plicosa* is probably *P. unisulcata* Dujardin, 1837, while the Belgian Pliocene fossil called *P. plicosa* by Nyst, 1881, is a different species named *P. nysti* by Sacco, 1892. Unless it is the same species, *P. nysti* Sacco is preoccupied by *P. nystii* Rayneval, Hecke & Ponzi, 1854, a name applied to an Italian Tertiary pyramidellid closely resembling the Belgian material figured by Nyst, 1843, as *P. terebellata* (Lamarck, 1804), which seems to be synonymous with *P. plicosa* Bronn.

form subsequent to its original publication. It is applied to the Recent species from the Nicobar Islands for which the name *Niso terebellum* (Dillwyn, 1817) is therefore available.

[*Pyramidella terebella*: Férussac, 1821. The first assignment of *Helix terebella* Müller, 1774, unemended, to its currently accepted genus.]

[*Pyramidella terebellata*: Férussac, 1821. The first assignment of *Auricula terebellata* Lamarck, 1804, to its currently accepted genus.]

*Pyramidella terebellata*: Sowerby, 1824. A new, but incorrect, generic placement of *Bulimus terebellatus* Lamarck; as such it is a junior secondary homonym (in the genus *Pyramidella*) of *Auricula terebellata* Lamarck. The name *P. terebellata* has also been used by different authors for various European fossil species of *Pyramidella*, but further synonymy of these misidentifications is beyond the scope of this paper. Conrad, 1833, identified fossil specimens from Maryland as *P. terebellata* (Lamarck), but these, and *Bonellia terebella* [sic] Conrad, 1841,<sup>7</sup> were later synonymized with *Bonellia lineata* Conrad, 1841, the only North American Miocene *Niso* recognized in Meek's (1864) checklist.

*Niso terebellata*: Bronn, 1831. The first assignment of *Bulimus terebellatus* Lamarck, 1804, to its currently accepted genus, but the Italian Tertiary species examined by Bronn (who included *Helix terebellata*: Brocchi, 1814, and *Niso eburnea* Risso, 1826, in his synonymy) was renamed *N. subterebellata* [incorrectly, as *subterebellatus*] Orbigny, 1852. The first correct placement of Lamarck's Eocene species in *Niso* was by Orbigny, 1850.

*Melania terebellata*: Anton, 1838.<sup>8</sup> A new, but incorrect, generic placement of *Bulimus terebellatus* Lamarck, within the subgenus *Bonellia*; as such it is a junior secondary homonym of *Melania terebellata* Nyst, 1835 [= *Eulimene terebellata*, a Pleistocene littorinid].

### *Helix corallina* Chemnitz, 1795

*Neues systematisches Conchylien-Cabinet* 11: 286–287, pl.210, figs.2084–85.

Description: Testa turrita, alba, nitida, glaberrima, tenui pellucida, anfractibus quinque inferioribus cylindratis sed spirae acuminate, apice exquisito, apertura suborbiculari.

In contrast to Chemnitz's *Turbo terebellum*, his *Helix corallina* was ignored by most subsequent authors, despite a characteristic description and figure which drew attention to the abrupt division between the cylindrical lower whorls and the acuminate spire. It was in fact the earliest species of 'stiliferid' eulimid to be brought to scientific notice, thirty years before Turton described *Phasianella* (now *Pelseneeria*) *stylifera* from the spines of an *Echinus* from Torbay, Devon; perhaps it was for that reason that it remained unrecognized by others for so long. The original provenance, in crevices of madreporan corals collected for calcination which had lain on the beach for a long time before being transported to Europe 'amongst ballast of a ship returned from the West Indian sugar islands', led Chemnitz to suppose that it may even have been a terrestrial species.

Although all the scientific names first published in the *Neues systematisches Conchylien-Cabinet* were suppressed by the ICZN in 1954, as mentioned above, most of the new names therein were made available by later authors. Petit de la Saussaye, 1841, was the first to adopt Chemnitz's name, as *Stylifer corallina* [sic], and applied that name to specimens found among madreporan coral in Mauritius, with which he compared but did not synonymize the West Indian *Stylifer subulatus* Broderip, 1832. It is now known (Warén 1980) that both names refer to the same highly variable circumtropical species, *Scalenostoma subulata* (Broderip, 1832), a parasite of the coral *Acropora palmata* (Lamarck). As originally noted by

<sup>7</sup> When describing the Miocene *Bonellia lineata* as a new species, Conrad stated: 'Very distinct from *B. terebella*\*', with a footnote '\* *Bulimus terebellatus*, Lam.'

<sup>8</sup> The title-page of Anton's *Verzeichniss der Conchylien* is dated 1839, but Kadolsky (1971) indicated that the work should be dated from 1838.



Chemnitz, there is, in some individuals of this species, a spire of several slender whorls followed by a rapid increase in the diameter of the shell. Warén (1980) suggested that this may correspond with a change of sex of the animal from a male to a female phase, as has been reported in the related genus *Echineulima*.

***Helix polita*** Pulteney, 1799

*Catalogues of the birds, shells, and some of the more rare plants of Dorsetshire*: 49.

Description: Testa imperforata, turrita; anfractibus decem planis laevibus; apertura oblonga-ovali.

Pulteney gave no reference to *Turbo politus* Linnaeus (unlike for many other species where he cited the *Systema Naturae*) and marked his description with a 'P', which may indicate that it was original. From his synonymy (*Strombiformis glaber* da Costa and *Turbo laevis* Pennant) and his comment that the whorls are 'flat, scarcely distinguishable, except by a slight commissure' he seems to be describing *Eulima glabra* (da Costa), but he does not mention the characteristic brown spiral bands of that species. On the other hand, his description of the shell from the Dorset coast as 'thick, solid, . . . white' suggests he had specimens of *Melanella alba* (da Costa). Most likely he confused the two species together. Thus the statement by Warén (1988) that 'Under the name *Strombiformis albus* da Costa, 1778, he [Pulteney] transferred *Turbo politus* to *Helix* and gave references which make it possible to establish the identity of the species for which he used Linnaeus' name' is not true.

Maton & Rackett (1807) separated the two species, under the specific names *Helix subulata* (= *Turbo subulatus* Donovan, 1804) and *H. polita*, citing p.49 of 'Pulteney in Hutch. Dorset' under the latter name. They also referred to figures 14 and 15 of plate 19, from the same work, in the synonymy of these two species respectively. No plates were published with the 1799 edition of the *Dorset Catalogues*, but Pulteney referred to an unpublished collection of plates under the title *Triton Britannicus* (see Bowden & Heppell (1968) for further details); these were among the manuscripts bequeathed to Maton when Pulteney died in 1801, and were eventually published in the 1813 edition of Hutchins's *History and Antiquities of the County of Dorset*. In the absence of original type material (Pulteney's shells were bequeathed to the Linnean Society and subsequently sold by auction in 1863; the purchaser is unrecorded), *Helix polita* Pulteney must be interpreted as having been restricted by Maton & Rackett to the species now known as *Melanella alba* (da Costa, 1778). It is not *Turbo politus* Linnaeus, 1758. The name is preoccupied in the genus *Helix* by *Helix polita* Müller, 1774.

***Turbo trifasciatus*** J. Adams, 1800

*Trans. Linn. Soc. [Lond.]* 5: 2, pl.1, figs.12–13 [generally misquoted as figs.13–14].

Description: T[urbo] testa laevi quinque anfractibus subobsoletus fasciatus, apertura ovali.

There has been considerable, and still incompletely resolved, confusion as to the correct application of this name, which has been variously assigned to *Barleeia*, *Cingula* and *Eulima*. Adams described the shell, taken from sand at the Wash, as whitish, with two transverse red bands on the first spire [i.e. the body whorl], and one on the second; the accompanying illustrations, which include an enlarged figure four times natural size, show these markings clearly.

Montagu (1803) supposed that Adams had intended his description for the same species as he was calling *Turbo unifasciatus* (in which the shell is marked 'with one, and rarely two bands of purplish-brown on the body, one on the second spire, and sometimes also on the third'), but noted that 'the figure given by Mr. Adams is longer in proportion than this shell'. This synonymy was accepted by Maton & Rackett (1807), who incorrectly state that the original material of Adams was from Pembroke, and by Dillwyn (1817), although both

authors used the junior name, *T. unifasciatus*. Montagu (1808, pl.20, fig.6) published an illustration of his species, which is identifiable as a *Barleeia*. It is synonymous with *Turbo ruber* J. Adams, 1797, the type species of *Barleeia* (Smith & Heppell 1991). As that name is a junior primary homonym of *Turbo ruber* Salis-Marschlins, 1793,<sup>9</sup> this species is now known as *Barleeia unifasciata* (Montagu, 1803).

Donovan (1804) after describing his new species *Turbo vittatus*, remarks: 'There is some reason for believing this to be the *Turbo trifasciatus* of Adams . . .' [wrongly stated to have been discovered on the coast of Tenby]. 'The account he gives does not exactly agree with our shell; he speaks of only two red bands on the first spire, instead of three; and the single spiral line arising from the posterior band, terminates in his shell after encircling the second volution, whereas, in all our specimens this line is continued on every wreath to the apex. Should his *T. trifasciatus* be intended for our shell, the outline also is very badly expressed.' Donovan's *T. vittatus* was soon recognized as a junior synonym of *T. cingillus* Montagu, 1803, the type species of the genus *Cingula*. Despite the considerable differences pointed out by Donovan, many later authors accepted his tentative opinion, possibly because many of Adams's figures of other species are in fact badly drawn. Jeffreys (1867) was more positive, and stated, of '*Rissoa*' *cingillus*, 'there is no doubt that it is the *Turbo trifasciatus* of Adams'. Nevertheless, in accordance with the custom of the time, he retained Montagu's 'universally accepted' name.

Most later workers followed Jeffreys's example, and Dautzenberg (1927) was able to cite only three authors (Monterosato, Chaster and Sykes) who had used the name *Cingula trifasciata*. Dautzenberg supported this, although agreeing that the species was much better known as *C. cingillus*, as 's'il est une coquille, parmi celles de J. Adams, que l'on puisse identifier, c'est assurément celle-ci, car elle est la seule dont la figuration soit à peu près satisfaisant'. Despite this vote of confidence in that interpretation of Adams's species, others did not accept it even as a rissoid and, until the 1960s (e.g. Fretter & Graham 1962, Coan 1964, Nordsieck 1968), *C. cingillus* continued to be accepted as the valid name. Since the 1970s, however, most authors have accepted, without comment and with varying degrees of certainty, *C. trifasciata* as the valid name for the type species of *Cingula* (e.g. Nordsieck 1972, Warén 1974, Ponder 1985, Graham 1988). Warén (*in litt.*) notes that all the other figures by Adams on the same plate are considerably more slender than the species they are assumed to be. If the figure of *Turbo trifasciatus* was similarly distorted, it seems to Warén more likely that it was drawn from *Cingula cingillus* than from *Eulima bilineata*, especially as the latter is hardly ever found on the shore, records more shallow than 25m invariably being based on misidentified *E. glabra*.

An opposing view, with which I agree, is that *Turbo trifasciatus* Adams is the species otherwise known as *Eulima bilineata* Alder, 1848. This was mooted in the monographs of Forbes & Hanley (1850) and Bucquoy *et al.* (1883), and expressed more definitely by Tryon (1886) and Winckworth<sup>10</sup> (1932), who have influenced other authors (e.g. Fretter & Graham 1962) down to the present time. Aartsen *et al.* (1984) defended their use of *Cingula cingillus* on the grounds that 'the original description and especially the figure [of *Turbo trifasciatus* Adams, 1800] make it much more probable that Adams's species was either *Eulima glabra* (da Costa, 1778) or *Eulima bilineata* Alder, 1848; the dimensions indicated for fig.13 are 6 × 1.4mm'. These dimensions are exactly right for an adult *E. bilineata*, and the

<sup>9</sup>The description of this species is probably based on a young and completely red specimen of *Littorina saxatilis* (Olivi, 1792). The reference to Martini 1781 (*Neues systematisches Conchylien-Cabinet* 5, pl.185, fig.1855) would agree with that identification, although that species is not otherwise recorded from Taranto, Italy, the locality given by Salis-Marschlins.

<sup>10</sup>Among the Winckworth MSS. at the Natural History Museum, London, is his card catalogue of species. His entry there for *Turbo trifasciatus* J. Adams, 1800, reads: 'Certainly = *Strombiformis bilineata* (Alder). . . . A very good figure.'

pattern of three brown spiral bands on each of the spire whorls and up to six on the body whorl of *E. glabra* would seem to rule out that possibility.

This seems to be a problem which can best be resolved by application to the ICZN for a ruling. The identity of *Turbo trifasciatus* could then be established by the designation of a neotype, or the name could be suppressed as a threat to the stability of zoological nomenclature. In the meantime, the name *Eulima bilineata* is retained herein as a nomen conservandum.

***Turbo elegantissimus* Montagu, 1803**

*Testacea Britannica*: 298, pl.10, fig.2.

It is inexplicable why Risso (1826) placed this species as first of the four nominal species included in his new genus *Eulima*, with a correct reference to Montagu's description and figure, as that is a species of *Turbonilla* [= *T. lactea* (Linnaeus, 1758), Pyramidellidae]. Risso's further reference to Donovan's figure of *Turbo acutus* [incorrectly cited as 'p.197' instead of 'pl.179'], which is another name for the same species, would seem to confirm that this was what Risso intended. And yet his description fails to mention the characteristic longitudinal ribs clearly shown in both figures, and apparently is applied to a eulimid. Macgillivray (1843) also included this species, as of Montagu, in *Eulima*, but it is not possible to tell whether his action was influenced by Risso's use of the name. Bucquoy *et al.* (1883) took the pragmatic view that the description of *E. elegantissima*, 'type de Risso', corresponded well to *E. polita* 'malgré les fausses références qu'il donne de Montagu et de Donovan', and accordingly cited *E. polita* Linnaeus, 1758, as the type species of *Eulima*.

***Turbo nitidissimus* Montagu, 1803**

*Testacea Britannica*: 299, pl.12, fig.1.

This species was included in the genus *Eulima* by Macgillivray (1843), but it is a pyramidellid. It has generally been cited as the type species of *Ebala* Gray, 1847, by monotypy.<sup>11</sup>

***Helix polita* Montagu, 1803**

*Testacea Britannica*: 398.

Although, as with *Helix polita* Pulteney, the cited synonymy might lead one to suppose that Montagu was here referring to *Eulima glabra* (da Costa, 1778), he clarified the identity in the Supplement to his *Testacea Britannica* (Montagu 1808) by indicating that his species was in fact da Costa's *Strombiformis albus*. He had earlier confused that species with his *Helix labiosa* [= *Rissoa membranacea* (J. Adams)]. Montagu also stated that 'minute specimens [of *H. polita*] are sometimes found on oysters and scallops'. Warén (1988) pointed out that these have been considered by later British authors to be species of *Vitreolina*, and Montagu was probably also including species of Pyramidellidae.

<sup>11</sup> Gougerot & Feki (1978) argued that this interpretation of *Ebala* was incorrect, as Gray had published Leach's manuscript name *Ebala elegantissima* in the synonymy of *Turbo elegantissimus* Montagu, 1803, a month before his fixation of *T. nitidissimus* as the type species. This interpretation was accepted by Sabelli *et al.* 1990, who regarded *Ebala* as a junior subjective synonym of *Turbonilla* Risso, 1826, and *Anisocycla* Monterosato, 1880, as the oldest available generic name for *Ebala* of authors. Warén (1994), however, has shown that the name *Ebala* should be retained in its accustomed sense, as used herein.



***Helix decussata* Montagu, 1803***Testacea Britannica*: 399.

This species was included in the genus *Eulima* by Macgillivray (1843) and Thorpe (1844), but it is a West Indian species of *Rissoina* [Rissoinidae].

***Melania nitida* Lamarck, 1804***Annls Mus. Hist. nat. Paris* 4: 432.

Description: *Melania* (*nitida*) *subulata*; anfractibus omnibus laevibus nitidissimus. Figured in *Annls Mus. Hist. nat. Paris* 8: pl. 60, fig. 6a, b (1806).

Lamarck applied this name to an Eocene fossil from the Paris Basin, confidently stating: 'Aucune espèce n'est plus facile à reconnoître que celle-ci'! It was recognized to be a marine species, and transferred to *Eulima* by Orbigny, 1850. Its present generic position is uncertain. Cossmann (1888) placed it in the subgenus *Subularia* Monterosato, 1884 (type species *Turbo subulatus* Donovan), a junior synonym of *Eulima*, but the shell characters of Lamarck's species are not right for that genus in its restricted sense. Because of its similarity to the Recent species of *Polygireulima* which Philippi identified as this species (see below) it is here tentatively placed in the same subgenus of *Melanella*.

Under the name *Helix nitida* (Lamarck), Brocchi, 1814, described an Italian Pliocene fossil, believing it to be conspecific with Lamarck's Eocene species. Brocchi seems to have been misled by the absence of scale with the figures issued to illustrate Lamarck's species, as his species is very much larger. *Eulima hastata*: Sismonda, 1847, is a misidentification of the Pliocene species as *E. hastata* Sowerby, 1834, a Recent species of *Melanella* from Ecuador; *E. subhastata* Orbigny, 1852, is a replacement name for *E. hastata*: Sismonda non Sowerby. Brocchi's *Helix nitida* was later synonymized (e.g. by Hörnes (1856) with '*Eulima polita* (Linnaeus)', but Brocchi's material is not that species as currently understood but *Melanella alba* (da Costa, 1778), which was until recently confused with it. A good figure of an Italian Pliocene specimen is given (as '*Melanella polita*') by Caprotti (1976, pl.9, fig.6).

*Melania nitida*: Philippi, 1836 (and *Eulima nitida*: Philippi, 1844) is a Recent Mediterranean species, misidentified as Lamarck's Eocene fossil. Forbes & Hanley (1850) used the name *Eulima polita* var. *nitida* for some British specimens resembling that figured by Philippi. According to Warén (1988), the identity of Philippi's species cannot be ascertained, although it has always been considered to be '*Eulima intermedia*' Cantraine, 1835. Monterosato (1890) disputed the validity of Cantraine's species, as the author had provided neither a figure nor references, and the name had been used to embrace several distinct taxa. He renamed Philippi's '*nitida*' *Acicularia pernula*, and it is in this sense that Warén (1988) designated a neotype for *Turbo politus* Linnaeus, 1758. For two other segregates of '*intermedia*' of authors Monterosato introduced the names *Acicularia lubrica* for *Eulima intermedia* sensu Jeffreys, 1867, and *A. monterosatoi* (from a manuscript name of de Boury) for *E. distorta* var. *gracilis* 'Jeffreys' (i.e. Forbes & Hanley, 1850) (non *E. gracilis* C. B. Adams, 1850).<sup>12</sup> These are now recognized as good species of *Melanella* s.s. and *Melanella* (*Polygireulima*) respectively.

<sup>12</sup> *Eulima gracilis* C. B. Adams, 1850, a Caribbean species of *Melanella*, published in April 1850, pre-dates *E. distorta* var. *gracilis* Forbes & Hanley published in August 1850.

***Turbo subulatus* Donovan, 1804<sup>13</sup>**

*British Shells* 5: pl.172.

The excellent figure provided by Donovan ensured ready recognition of this species. The name was in use for many years, assigned to the genera *Eulima*, *Leiostraca* (of which it is the type species) and *Strombiformis*, before being relegated to the junior synonymy of *Strombiformis glaber* da Costa, 1778. *Helix subulata*: Montagu, 1807, is merely a new generic placement for Donovan's species, but *H. subulata* Brocchi, 1814, was proposed independently as a new species of Italian Tertiary fossil. Nonetheless, it too seems to be a synonym of *Eulima glabra* (da Costa), as Warén (1992) states he examined the specimens in the Brocchi collection in Milan and could not distinguish them from that Recent species. Various other European Tertiary fossils, however, which had formerly been called *Eulima subulata*, have subsequently been renamed, such as *E. eichwaldi* Hörnes, 1856, *E. taurinensis* Sacco, 1892 (type species of *Sulcosubularia* Sacco, 1892) and *E. burdigalina* Cossmann & Peyrot, 1919.

*Turbo subulatus* was designated as type species of *Eulima* by Herrmannsen, 1847, but many authors regarded the type of that genus, incorrectly, as *Turbo politus* Linnaeus or *Helix polita* sensu Montagu. Doubts about the validity of Herrmannsen's designation were finally resolved when it was ratified by the ICZN in Opinion 1718 (1993).

***Turbo fasciatus* Renier, 1804**

*Tavola alfabetica delle Conchiglie adriatiche*: x [also cited as p.4].

Renier's *Tavola alfabetica* appears to be extremely rare, perhaps known as an original work from a single copy. Because of doubts as to the validity of its publication, it was suppressed by the ICZN in Opinion 316 (1954). Details of this work are given by Iredale (1922), in Opinions 316 (1954) and 427 (1956) and in an account of the author by Ghisotti (1974) [where the date of the *Tavola* is unfortunately misprinted as '1894']. Although some of Renier's names could be identified from footnotes or illustrations, his *Turbo fasciatus* is a nomen nudum.<sup>14</sup> Despite the present rarity of the *Tavola*, Renier's names were frequently cited by other Italian workers, especially Brocchi, Meneghini and Nardo. The name *T. fasciatus* Renier was cited by Brocchi, 1814, in the synonymy of '*Helix*' *subulata* (Donovan, 1804) but, although it is frequently attributed to Brocchi when cited as a synonym of *Eulima glabra* (da Costa), it appears never to have been adopted and so is unavailable under Article 11e of the Code. It does not preoccupy *Eulima fasciata* Watson, 1883, as not only is *Turbo fasciatus* 'Brocchi' unavailable but it is preoccupied in the genus *Turbo* by *T. fasciatus* Pennant, 1777<sup>15</sup> = *Cochlicella acuta* (Müller, 1774) [Helicidae].

***Helix incurva* Renier, 1804**

*Tavola alfabetica delle Conchiglie adriatiche*: xi [also cited as p.4].

As stated above, Renier's *Tavola alfabetica* was suppressed by the ICZN. Keen, in Opinion 427 (1956), had noted *Helix incurva* as one of the new names published in that work,

<sup>13</sup> The dates of the five volumes of Donovan's *Natural History of British Shells* are often incorrectly cited, and those given by Coleman 1932 (*Biol. Bull.* 62: 225) are wrong. A note by B. B. Woodward in the copy in the National Museums of Scotland library states that the work was issued in 60 monthly parts, each with 3 plates, of which parts 1–6 probably appeared in 1799, parts 7–18 in 1800, parts 19–30 in 1801, parts 31–42 in 1802, parts 43–54 in 1803, and parts 55–60 in 1804. According to this the dates of the plates would be: pls.1–18, 1799; pls.19–54, 1800; pls.55–90, 1801; pls 91–126, 1802; pls.127–162, 1803; pls.163–180, 1804.

<sup>14</sup> Renier states it had been neither described nor figured, and that others have included it in *Turbo pullus* (= *Tricolia pullus* (Linnaeus, 1758)). There is thus no evidence that Renier intended this name to apply to a eulimid.

<sup>15</sup> *Turbo fasciatus*: Fleming, 1828 = *Helix fasciata* Adams, 1800 (non da Costa, 1778) = *Lacuna parva* (da Costa, 1778).

and it was duly suppressed by the Commission. The identity of Renier's species has been misunderstood. For many years the species was assumed to be the same as the Eocene fossil *Melania distorta* Defrance, 1823 (often cited as of Deshayes, whose manuscript name was adopted by Defrance), and was known by the name *Eulima* (or *Balcis*) *distorta*.<sup>16</sup> Defrance believed that his species was identical with one still living on the English coast. Philippi (1836: pl.9, fig.10) gave a good figure of a Recent specimen from near Palermo, Sicily, under the name *Melania distorta* 'Deshayes'. Jeffreys (1884) declared that he had compared hundreds of living examples with fossil specimens from the Paris Basin 'and I find myself conscientiously bound to unite them', but other authors considered the Recent species distinct from the fossil. Weinkauff (1868) reviewed the usage of the name *distorta*, and proposed the replacement name *Eulima philippii* for the Recent species figured by Philippi. That name had already been proposed (as *E. philippi*) by Rayneval, Hecke & Ponzi, 1854,<sup>17</sup> as a replacement name for '*distorta*' of authors (non Defrance), as applied to an Italian Tertiary fossil, which Rayneval *et al.* also compared with Philippi's description and figure.<sup>18</sup>

As Weinkauff's replacement name was thereby preoccupied, Bucquoy *et al.* (1883) resurrected *Eulima incurva* '(Renier)' for *E. philippii* Weinkauff non Rayneval, Hecke & Ponzi. In fact that name is available from its publication by Brusina (1870) who, in his discussion of the Chiareghini MS. name *Turbo curvatus*, cited '*Eulima incurva* Renier' as a synonym and stated that it was the species for which Weinkauff had proposed the name *E. philippii*, but which was not acceptable because Renier's name had priority. For *E. incurva* and four other species, including the first valid publication of his new species *E. devians*, Monterosato (1884) introduced the subgeneric name *Vitreolina*, of which *E. incurva* was subsequently designated the type species, by Bucquoy *et al.* (1898). Tryon (1886), in his monograph of Eulimidae, accepted *E. incurva* as of Renier, 1804, as did Dautzenberg (1889), who pointed out that the resemblance noted by Jeffreys between the Recent and fossil species was no more than simple coincidence, as the two faunas are completely different and possess no other species in common.

No one other than Iredale (1922) seems to have queried Brusina's identification of Renier's *Helix incurva* with the *Turbo curvatus* of the Chiareghini MS. Renier did not mention Chiareghini, but indicated his new species by reference to three figures, all of which are species of Lymnaeidae. Renier's intentions are confirmed by his transfer of his *H. incurva* to *Lymnaea* in 1807 (and see discussion under '*Lymnaea incurvata* Renier, 1807', below). Fortunately the identity of Renier's species need not concern us, as the name has been suppressed by the ICZN. As noted above, it was first made available by Brusina who used the name for the Recent species of *Vitreolina* which had been misidentified by many authors as the fossil *E. distorta* (Defrance), and renamed *V. philippii* (Weinkauff).

Winckworth (1932) listed *Balcis devians* (Monterosato) as a British species, with *distorta* sensu Jeffreys as a synonym, but did not mention *E. incurva* except as the type species of *Vitreolina*. Warén (1984) observed that 'the specific names *incurva* and *devians* . . . have been used for a mixture of small, curved European eulimids' and accepted *Vitreolina philippii* as the valid name of a Recent species (i.e. implying that *Eulima philippii* Weinkauff and *E. philippi* Rayneval, Hecke & Ponzi are synonymous homonyms). This had also been the opinion of Monterosato (1884), but he did not use that name in place of *incurva* as he assumed the latter name to take priority from 1804. Smith & Heppell (1991) listed the British species as

<sup>16</sup> Cossmann (1907) pointed out that Deshayes himself, in 1862, had confused two different fossil species under the name *Eulima distorta* (see the summary of synonymy below).

<sup>17</sup> The authorship of the *Catalogue des fossiles du Monte Mario (près Rome), recueillis par M. le C<sup>te</sup> de Rayneval, M<sup>sr</sup> Van den Hecke et M. le professeur Ponzi* . . . Versailles, 1854, is generally attributed to 'Rayneval & Ponzi' or 'Rayneval' alone.

<sup>18</sup> Rayneval *et al.* actually cited Philippi's pl.9, fig.6. This is obviously a lapsus calami as that is a figure of *Melania acicula* Philippi, 1836 (= *Eulimella acicula* [Pyramidellidae]), for which there would have been no need of a replacement name. Presumably a handwritten '10' was read by the printer as a '6'.



*Vitreolina philippi* on Warén's advice, with *Balcis devians* and 'Eulima incurva auctt. non Eulima incurva Bucquoy, Dautzenberg & Dollfus, 1882 [sic]' as synonyms. Sabelli *et al.* (1990) listed *incurva* and *philippi* as two separate Mediterranean species. These names, however, must be synonymous. *E. incurva* was understood by both Brusina and Bucquoy *et al.* to be exactly equivalent to *E. philippii* Weinkauff. That name is preoccupied by *E. philippi* Rayneval, Hecke & Ponzi for a Tertiary fossil which apparently happens to be synonymous with Weinkauff's Recent species. Piani (1980), in his checklist of Mediterranean shells, listed 'Balcis devians (Monterosato, 1875)' and 'Balcis incurvata (Renier, 1807)'. These are presumably *Vitreolina devians* Monterosato, 1884 and *V. philippi* (Rayneval, Hecke & Ponzi, 1854), which most authors have regarded as synonymous; *V. devians* is omitted (even as a synonym) from the Mediterranean checklist of Sabelli *et al.* (1990)

*Vitreolina philippi* (Rayneval, Hecke & Ponzi) is distributed from Norway to the Mediterranean. According to Graham (1988) it is probably the commonest eulimid around the British Isles, where it occurs predominantly on southern and western shores from the lower shore down to 200m. Warén (1984) states that in Sweden it is parasitic on the ophiuroids *Amphiura filiformis* (Müller) and species of *Ophiura*, while Rinaldi (1994) recorded it from Sardinia on the regular echinoids *Arbacia lixula* (Linnaeus) and *Paracentrotus lividus* (Lamarck). Graham (1988) indicated that, if it has been correctly identified, it has also been found on crinoids and holothurians, thus having a wider choice of host than most other species.

### **'Lymnaea incurvata** Renier, 1807'

*Tavola per servire alle classificazione e connescenza degli animali*: VIII.

Although Sabelli *et al.* (1990) included 'incurvata AA' [auctorum] in the synonymy of *Vitreolina incurva* 'B.D.D. 1883', I have been unable to discover any mention of this specific name in any likely genus, except for the statement by Brusina (1870) that Renier published his *Helix incurva* 'nuovamente nel 1807 come *Lymnaea incurvata*'. This statement is incorrect, as Renier, 1807, maintained the name *incurva*, not *incurvata*. As noted above, under *Helix incurva* Renier, 1804, that name was used for a lymnaeid and not a eulimid. Renier's 1807 work was suppressed by the ICZN in Opinion 427 (1956).

### **Helix subulata** Brocchi, 1814

*Conchiologia fossile subapennina* 2: 305, pl.3, figs.5a, b.

Although this name was proposed for a new species of Italian Pliocene fossil it is conspecific with the homonymous *Turbo subulatus* Donovan, 1804, and thus a junior synonym of *Eulima glabra* (da Costa, 1778). For further discussion see under *Turbo subulatus* above.

### **Turbo terebellum** Dillwyn, 1817

*A descriptive Catalogue of Recent shells, etc.* 2: 872.

This is the first valid publication of the name for the species of *Niso* from the Indian Ocean originally described by Chemnitz. For discussion of the subsequent usage of and confusion surrounding this name see above under *Turbo terebellum* Chemnitz, 1788.

### **Turbo glaber** Brown, 1818

*Trans. R. Soc. Edinb.* 8: 463, pl.10, fig.2.

Description: Shell subulate, with ten glossy well defined whorls, white, aperture sub-rotund.

This is one of the new species described in an Appendix to a paper by T. Allan on the

geology of the environs of Nice. Brown gives no indication of size; the figure is 9mm high, but other figured species, for which the size is given, are not drawn to a uniform scale. Risso (1826) based his *Eulima glaberrima* on this figure, which Arnaud (1978) thought was probably intended to be the *Turbo politus* of authors [i.e. *Melanella alba* (da Costa, 1778)]. I do not agree with that supposition; the figure could represent a small straight-spined eulimid, such as a species of *Melanella* (*Balcis*), but equally it could have been intended for a species of *Eulimella* [Pyramidellidae]. It must be dismissed, in the absence of identifiable original material, as a *nomen dubium*.

***Melanella dufresnii* Bowdich, 1822**

*Elements of Conchology, including the fossil genera and the animals.* Part I. Univalves: pl.6, fig.17.

Description [of *Melanella*, p.27]: Semi-transparent, mouth invaded by the last whorl; white. Turreted; spire curved. Marine.

There is no separate description of the sole species included in *Melanella*, proposed as a new subgenus of Lamarck's genus *Melania* (although used as a full genus in combination with the specific name on the plate), so the subgeneric characters, together with the rough figure, must suffice. These are sufficient to establish that it is a eulimid, and neither a *Niso* nor a 'styliferid'. One further clue to its identity is Bowdich's statement that the genus *Melania* as a whole [obviously excluding the fossil species] 'is, probably, entirely foreign to Europe'. This precludes any Mediterranean provenance for *Melanella dufresnii*. From the above review of eulimid species recognized at this time, it is evident that it cannot be a junior synonym of any species already described. The first non-European species (excluding *Niso*) to be described after 1822 was *Phasianella inflexa* Blainville, 1825, from Mauritius, and it may be that these two taxa are the male (*dufresnii*) and female (*inflexa*) of the same species.

Bowdich indicated that his original material of *Melanella* was 'in the cabinet of M. Dufresne'.<sup>19</sup> Dufresne's shells were acquired by the University of Edinburgh in 1819 and are now part of the collections of the National Museums of Scotland. Although this collection has been integrated into the main systematic series of Mollusca, the Dufresne specimens are easily recognizable as they have been left in their original condition, affixed by glue to small rectangles of cardboard, on which details of identification and locality are written in French in ink. At some time after acquisition, the abbreviation 'Duf[resne]' has been written on each board in pencil. A search for the type specimen of *M. dufresnii* amongst this Dufresne material led to the discovery of such a board, housed amongst the Rissoidae, to which were attached two specimens identified as '*Rissoa polita*', with no locality (Fig. 1). These are certainly a species of *Melanella*, as currently understood, and were accepted by Heppell, in Smaldon, Heppell & Watt (1976), as the lectotype (Fig. 2) and paralectotype [not holotype, *pace* Warén 1984] of *M. dufresnii*. These specimens are the only eulimids represented amongst the Dufresne material. Although Bowdich's original figure is crudely drawn, the resemblance is close enough to support the likelihood of these specimens being part of the original syntype series for which Bowdich proposed his new name.

Winckworth (1934) was misled by Bowdich's footnote listing localities from which fossil '*Melania*' had been obtained, and presumed that *M. dufresnii* too was 'a fossil, and possibly a poor drawing of an eulimid, but it seems to me more probable that it is a fairly good drawing of a stiliferid, judging from the appearance of the whorls and the shape of the mouth: curved spires are not unknown in Stiliferidae'. He advised that 'as the type specimen has not been found, exact determination is not feasible, and the safest course is to avoid the use of the name *Melanella* until further evidence is available'. *M. dufresnii* is the type species by monotypy, and the recognition of a type specimen dispels all remaining doubt about the

<sup>19</sup> For details of Dufresne, his collections, and why they came to Edinburgh, see Sweet (1970).



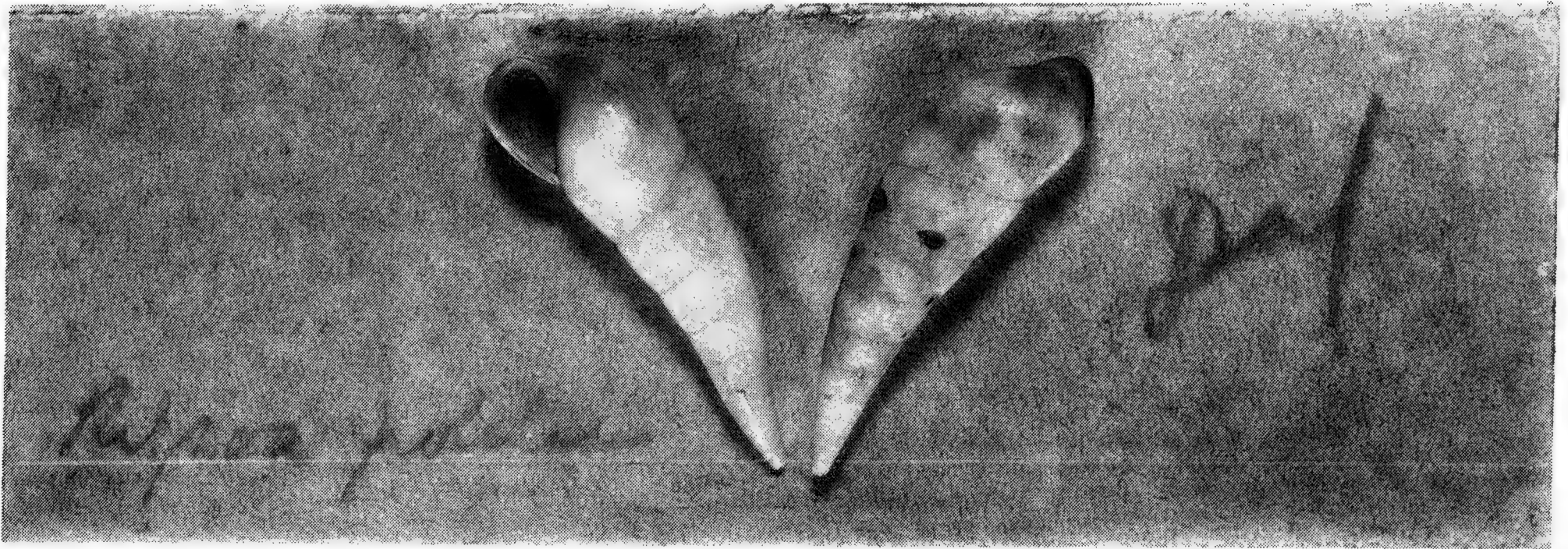


Fig. 1. The lectotype (left) and paralectotype of *Melanella dufresnii* Bowdich, 1822, as found in the Dufresne collection, before cleaning. NMSZ 1976.3.1-2.

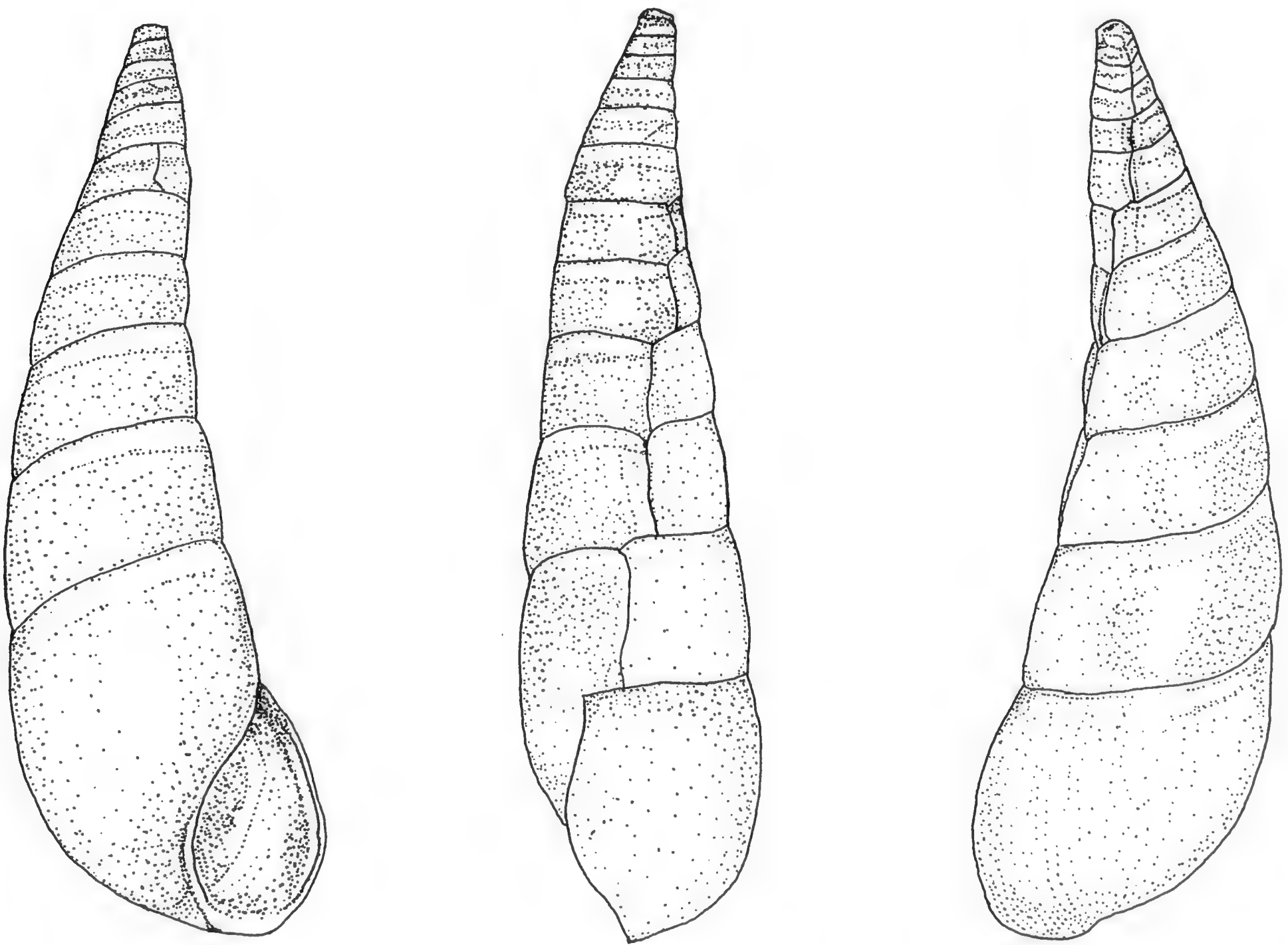


Fig. 2. *Melanella dufresnii* Bowdich, 1822. Drawing of lectotype. NMSZ 1976.3.1. Dimensions: 22.9 × 7.4mm.

correct application of the generic name. Apart from the evidence of the Dufresne specimens themselves, the hypothesis that the type species was a fossil is disproved by Blainville (1825). He was at least as familiar with the Dufresne collection in Paris as Bowdich, yet indicates that only one fossil species analagous to his *Phasianella inflexa* was known, according to Defrance, which must be his *Melania distorta*, believed at that time to be identical to the Recent species now known as *Vitreolina philippi*.

Because of the uncertainty of its true identity, the name *Melanella dufresnii* has been very



little used, except as the name of the type species. It is the oldest available name for *Eulima arcuata* Sowerby, 1865 (non *E. arcuata* C. B. Adams, 1849, a Caribbean species of *Melanella*). The species has been known, especially in Hawaii, as *Eulima* (or *Balcis*) *thaanumi* Pilsbry, 1917, but as the taxonomy of the larger species of *Melanella* is very confused, and museum collections abound with misidentifications, further discussion of the synonymy and distribution of this species is deferred to a separate paper.

## SUMMARY OF SYNONYMY

**Note:** Specific names are listed here in alphabetical order; where the same name occurs more than once the order is determined by genus and then by date. Subsequent usage (misidentifications and new generic placements) is indicated by a colon (:) before the author's name.

*Strombiformis albus* da Costa, 1778 = *Melanella* (*Balcis*) *alba* (da Costa, 1778)

*Turbo albus* Pennant, 1777. **Nomen dubium.** Suppressed by the ICZN.

*Turbo albus*: Donovan, 1804 = *Melanella* (*Balcis*) *alba* (da Costa, 1778)

*Eulima anglica* Sowerby, 1834 = *Melanella* (*Balcis*) *alba* (da Costa, 1778)

*Eulima arcuata* C. B. Adams, 1849 = *Melanella arcuata* (C. B. Adams, 1849)

*Eulima arcuata* Sowerby, 1865 = *Melanella dufresnii* Bowdich, 1822

*Eulima bilineata* Alder, 1848 [Nomen conservandum]

*Helix corallina* Chemnitz, 1795. **Invalid:** published in a work suppressed by the ICZN.

*Stylifer corallina* Petit de la Saussaye, 1841 = *Scalenostoma subulata* (Broderip, 1832)

*Turbo curvatus* Chierighini MS. = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Eulima decussata*: Macgillivray, 1843 = *Rissoina decussata* (Montagu, 1803)

[**Rissoinidae**]

*Helix decussata* Montagu, 1803 = *Rissoina decussata* (Montagu, 1803) [**Rissoinidae**]

*Vitreolina devians* Monterosato, 1884 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Eulima distorta*: Cantraine, 1835 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Melania distorta* Defrance, 1823 = *Eulima* (s.l.) *distorta* (Defrance, 1823)

*Melania distorta*: Philippi, 1836 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Melania distorta*: Deshayes, 1862 = *Eulima* (s.l.) *erronea* Cossmann, 1904

*Melanella dufresnii* Bowdich, 1822

*Niso eburnea* Risso, 1826. **Nomen dubium.**

*Niso eburnea*: Philippi, 1836 = *Niso acarinatoconica* Sacco, 1892 [**Pliocene**]

*Eulima elegantissima*: Risso, 1826 = ? *Melanella* (*Polygireulima*) *polita* (Linnaeus, 1758)

*Eulima elegantissima*: Macgillivray, 1843 = *Turbonilla lactea* (Linnaeus, 1758)

[**Pyramidellidae**]

*Helix fasciata* Adams, 1800 = *Lacuna parva* (da Costa, 1778) [**Littorinidae**]

*Turbo fasciatus* Pennant, 1777 = *Cochlicella acuta* (Muller, 1774) [**Helicidae**]

*Turbo fasciatus* Renier, 1804. **Invalid:** nomen nudum, and published in a work suppressed by the ICZN.

*Turbo fasciatus*: Brocchi, 1814. Synonymized with *Eulima glabra* (da Costa, 1778).

**Unavailable:** never adopted as the name of a taxon (ICZN Article 11e).

*Turbo fasciatus*: Fleming, 1828 = *Lacuna parva* (da Costa, 1778) [**Littorinidae**]

*Eulima glabra* Jeffreys, 1884 = *Melanella pseudoglabra* Dautzenberg & Fischer, 1912

*Eulima glabra*: Dautzenberg & Fischer, 1912 = *Eulima glabra* (da Costa, 1778)

*Strombiformis glaber* da Costa, 1778 = *Eulima glabra* (da Costa, 1778)

*Turbo glaber* Brown, 1818. **Nomen dubium.**

*Eulima glaberrima* Risso, 1826. **Nomen dubium.**

*Eulima gracilis* C. B. Adams, 1850 = *Melanella gracilis* (C. B. Adams, 1850)

*Eulima distorta* var. *gracilis* Forbes & Hanley, 1850 = *Melanella (Polygireulima) monterosatoi* (Monterosato, 1890)

*Eulima hastata* Sowerby, 1834 = *Melanella hastata* (Sowerby, 1834)

*Eulima hastata*: Sismonda, 1847 = *Melanella (Balcis) alba* (da Costa, 1778)

*Eulima incurva* Brusina, 1870 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Helix incurva* Renier, 1804. **Invalid:** published in a work suppressed by the ICZN.

*Lymnaea incurva*: Renier, 1807. **Invalid:** published in a work suppressed by the ICZN.

*Balcis incurvata*: Piani, 1980 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

'*Lymnaea incurvata* Renier, 1807'. ? *a cheironym.*

*Eulima intermedia* Cantraine, 1835 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Eulima intermedia*: Jeffreys, 1867 = *Melanella lubrica* (Monterosato, 1890)

*Turbo laevis* Pennant, 1777. **Nomen dubium.** Suppressed by the ICZN.

*Eulima lineata* Sowerby, 1834 = *Eulima glabra* (da Costa, 1778)

*Eulima lineata*: Alder, 1848 = *Eulima bilineata* Alder, 1848

*Acicularia lubrica* Monterosato, 1890 = *Melanella lubrica* (Monterosato, 1890)

*Acicularia monterosatoi* Monterosato, 1890 = *Melanella (Polygireulima) monterosatoi* (Monterosato, 1890)

*Eulima nitida*: Philippi, 1844 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Eulima nitida*: Orbigny, 1850 = *Melanella (Polygireulima) nitida* (Lamarck, 1804)

*Eulima polita* var. *nitida*: Forbes & Hanley, 1850 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Helix nitida*: Brocchi, 1814 = *Melanella (Balcis) alba* (da Costa, 1778)

*Melania nitida* Lamarck, 1804 = *Melanella (Polygireulima) nitida* (Lamarck, 1804)

*Melania nitida*: Philippi, 1836 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Eulima nitidissima*: Macgillivray, 1843 = *Ebala nitidissima* (Montagu, 1803)

### [Pyramidellidae]

*Pyramidella nystii* Rayneval, Hecke & Ponzi, 1854 = *Pyramidella plicosa* Bronn, 1838

### [Pliocene]

*Acicularia pernula* Monterosato, 1884 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Eulima philippi* Rayneval, Hecke & Ponzi, 1854 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Eulima philippii* Weinkauff, 1868 = *Vitreolina philippi* (Rayneval, Hecke & Ponzi, 1854)

*Helix polita* Pulteney, 1799 = *Melanella (Balcis) alba* (da Costa, 1778)

*Helix polita*: Montagu, 1803 = *Melanella (Balcis) alba* (da Costa, 1778)

*Phasianella polita*: Fleming, 1828 = *Melanella (Balcis) alba* (da Costa, 1778)

*Pyramis politus*: Brown, 1827 = *Melanella (Balcis) alba* (da Costa, 1778)

*Turbo politus* Linnaeus, 1758 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Eulima porcellana* A. Adams, 1851 = *Melanella (Balcis) alba* (da Costa, 1778)

*Eulima intermedia* var. *rubrotincta* Jeffreys, 1867 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Rissoa sinuosa* Scacchi, 1836 = *Melanella (Polygireulima) polita* (Linnaeus, 1758)

*Phasianella styliifera* Turton, 1825 = *Pelseneeria styliifera* (Turton, 1825)

*Velutina styliifera*: Fleming, 1828 = *Pelseneeria styliifera* (Turton, 1825)

*Eulima subangulata* Sowerby, 1834 = *Melanella (Balcis) alba* (da Costa, 1778)

*Eulima subhastata* Orbigny, 1852 = *Melanella (Balcis) alba* (da Costa, 1778)

*Eulima subulata*: Risso, 1826 = *Eulima glabra* (da Costa, 1778)

*Helix subulata*: Montagu, 1807 = *Eulima glabra* (da Costa, 1778)

*Helix subulata* Brocchi, 1814 = *Eulima glabra* (da Costa, 1778)

- Phasianella subulata*: Fleming, 1828 = ***Eulima glabra*** (da Costa, 1778)  
*Pyramis subulatus*: Brown, 1827 = ***Eulima glabra*** (da Costa, 1778)  
*Stilifer subulatus* Broderip, 1832 = ***Scalenostoma subulata*** (Broderip, 1832)  
*Stylifer subulatus*: Broderip, 1832 = ***Scalenostoma subulata*** (Broderip, 1832)  
*Turbo subulatus* Donovan, 1804 = ***Eulima glabra*** (da Costa, 1778)  
*Bonellia terebella* Conrad, 1841 = ***Niso lineata*** (Conrad, 1841) [**Miocene**]  
*Helix terebella* Müller, 1774 = ***Pyramidella dolabrata*** (Linnaeus, 1758) var. *terebella* (Müller, 1774)  
*Pyramidella terebella*: Férussac, 1821 = ***Pyramidella dolabrata*** (Linnaeus, 1758) var. *terebella* (Müller, 1774)  
*Auricula terebellata* Lamarck, 1804 = ***Pyramidella terebellata*** (Lamarck, 1804) [**Eocene**]  
*Bonellia terebellata*: Deshayes, 1838 = ***Niso terebellata*** (Lamarck, 1804) [**Eocene**]  
*Bulimus terebellatus* Lamarck, 1804 = ***Niso terebellata*** (Lamarck, 1804) [**Eocene**]  
*Helix terebellata*: Brocchi, 1814 = ***Niso acarinatoconica*** Sacco, 1892 [**Pliocene**]  
*Janella terebellata*: Grateloup, 1838 = ***Niso burdigalensis*** Orbigny, 1852 [**Miocene**]  
*Melania terebellata*: Anton, 1839 = ***Niso terebellata*** (Lamarck, 1804) [**Eocene**]  
*Niso terebellata*: Bronn, 1831 = ***Niso acarinatoconica*** Sacco, 1892 [**Pliocene**]  
*Niso terebellata*: Orbigny, 1850 = ***Niso terebellata*** (Lamarck, 1804) [**Eocene**]  
*Pyramidella terebellata*: Férussac, 1821 = ***Pyramidella terebellata*** (Lamarck, 1804) [**Eocene**]  
*Pyramidella terebellata*: Sowerby, 1824 = ***Niso terebellata*** (Lamarck, 1804) [**Eocene**]  
*Pyramidella terebellata*: Conrad, 1833 = ***Niso lineata*** (Conrad, 1841) [**Miocene**]  
*Turbo terebellatus*: Brocchi, 1814 = ***Pyramidella plicosa*** Bronn, 1838 [**Pliocene**]  
*Bulimus terebellum* Bruguière, 1792 = ***Pyramidella dolabrata*** (Linnaeus, 1758) var. *terebella* (Müller, 1774)  
*Niso terebellum*: Philippi, 1844 = ***Niso acarinatoconica*** Sacco, 1892 [**Pliocene**]  
*Pyramidella terebellum*: G. Fischer, 1807 = ***Pyramidella dolabrata*** (Linnaeus, 1758) var. *terebella* (Müller, 1774)  
*Turbo terebellum* Chemnitz, 1788. **Invalid**: published in a work suppressed by the ICZN.  
*Turbo terebellum* Dillwyn, 1817 = ***Niso terebellum*** (Dillwyn, 1817)  
*Trochus terebellus* Dillwyn, 1817 = ***Pyramidella dolabrata*** (Linnaeus, 1758) var. *terebella* (Müller, 1774)  
*Eulima thaanumi* Pilsbry, 1917 = ***Melanella dufresnii*** Bowdich, 1822  
*Turbo trifasciatus* J. Adams, 1800 = ***Eulima bilineata*** Alder, 1848 [Nomen conservandum]  
*Turbo trifasciatus*: Montagu, 1803 = ***Barleeia unifasciata*** (Montagu, 1803)  
*Turbo trifasciatus*: Donovan, 1804 = ***Cingula cingillus*** (Montagu, 1803)  
*Eulima turgidula* Deshayes, 1862 = ***Eulima*** (s.l.) ***distorta*** Defrance, 1823  
*Stilifer turtoni* Broderip, 1832 = ***Pelseneeria stylifera*** (Turton, 1825)  
*Stylifer turtoni* Broderip, 1832 = ***Pelseneeria stylifera*** (Turton, 1825)

## TAXA OF THE GENUS GROUP

Warén (1984) published a generic revision of the Eulimidae, summarizing and illustrating the characters of all supraspecific taxa then known, with details of their type species and synonymy. Most of those taxa are not relevant to the present study, and I limit myself here to an outline of the earliest described genera, and those relating to the common European eulimids of inshore waters, bringing up to date the typification and synonymy in the light of work published since Warén's revision and recent rulings by the ICZN.

As mentioned in the historical section above, the early attempts to fit the eulimids into



the classifications of Linnaeus and Lamarck were not successful. *Strombiformis* da Costa, 1778, introduced for a miscellany of narrow shells with pointed apices, has had considerable usage even into very recent times. That name was first resurrected for use as a eulimid genus by Iredale (1915), who designated *S. glaber* da Costa as the type. Unfortunately he had overlooked an earlier designation by Harris (1894), as pointed out by Winckworth (1934). Harris was wrong in supposing that da Costa's first species must be selected as type, but nevertheless the words 'his first species, and therefore the type of the genus is *Turbo perversus* Linn.' constitute a valid type fixation. *T. perversus* Linnaeus, 1758, is the terrestrial *Balea perversa* [Clausiliidae], and *Strombiformis* is not, therefore, available for generic use in the family Eulimidae. As it was, however, a threat to the name *Balea*, in common use, Warén (1992a) applied to the ICZN for conservation of the latter name. *Strombiformis* da Costa was duly suppressed by the Commission in Opinion 1718 (1993).

*Melanella* Bowdich, 1822, is the oldest generic name with a eulimid type species, *M. dufresnii* Bowdich, 1822, the identity of which has been discussed above. It is a widespread and speciose genus, the limits of which are difficult to define. Fischer (1887) considered Bowdich's revision of the old and heterogeneous Lamarckian genus *Melania* 'une tentative remarquable d'épuration', and advocated the adoption of *Melanella*. He had already pointed out two years previously, in his influential *Manuel de Conchyliologie*, that *Melanella* should replace *Eulima* on grounds of priority, but failed to act accordingly. Cossmann (1888) took a contrary view, that Bowdich had incorrectly applied the name which Dufresne himself, in manuscript, had intended for a different genus. A further factor which mitigated against general usage of *Melanella* was the introduction by Swainson, 1840, of the same name for a genus much more closely related to *Melania*.

*Melanella*, in the eulimid sense, was not much used as a generic name until 1915, when it was reintroduced by Dall (1915), with *Eulima* as a subgenus. Even after that its status in relation to other genera was not well defined. Warén (1984) commented that, in the later literature, *Balcis*, *Melanella* and *Eulima* were used more or less at random. Most often *Melanella* was used in a general sense, in place of *Eulima* s.l., or as a catch-all for those species which were not closely related to *Balcis* or *Leiostraca* (see below), many of which would now be placed in *Vitreolina*. In fact many of the better-known species formerly assigned to *Eulima* belong here. The genus includes the largest species of Eulimidae, as *M. grandis* (A. Adams, 1853) may reach 70mm (Warén, *in litt.*). The shells are solid, white, without sculpture, and often with a characteristic flexed spire. The sexes are separate, sometimes with a noticeable difference in the size and proportions of the shells of the males and females, the females being larger and fatter. Those species for which the host is known are parasitic on holothurians (Warén 1984); no radula has been reported, so they presumably suck tissue fluids from their host through an extendable proboscis.

*Eulima* Risso, 1826, had four nominal species originally included: *E. elegantissima* Montagu, *E. glaberrima* Risso, *E. striata* Brocchi, and *E. subulata* Brocchi. The first species was frequently cited as the type and a supposed synonym of *E. polita* (Linnaeus), but it seems to have been largely based on *Turbonilla elegantissima* (Montagu, 1803) [Pyramidellidae] (see discussion of *Turbo elegantissimus* Montagu, 1803, above). Bucquoy, *et al.* (1883) argued that Risso gave false references, to support their contention that this species was *E. polita*. Risso's second species referred to an illustration of '*Turbo glaber* Allan, 1818', the identity of which is uncertain (Arnaud 1978).<sup>20</sup> The third species is *Turbo striatus* Brocchi, preoccupied in the

<sup>20</sup> For discussion see *Turbo glaber* Brown, 1818, above. Risso was referring to the 'Sketch of the geology of the environs of Nice' by Thomas Allan 1818 (*Trans. R. Soc. Edinb.* 8: 427–464), which has an Appendix of fossil shells by Thomas Brown (pp.455–464). The names of the 33 new species of Mollusca included there should be attributed to Brown, who described and figured them. Arnaud (1978) believed Brown's *Turbo glaber* was probably intended to be the *Turbo politus* of authors (non Linnaeus) [i.e. *Melanella alba* (da Costa, 1778)], but it is not even certain that Brown's figure represents a eulimid.

genus *Turbo* and therefore unavailable. The identity of *Helix subulata* Brocchi, the fourth species and the only one figured by Risso, was discussed by Warén (1992a) who concluded, from examination of Brocchi's original material, that it is *Eulima glabra* (da Costa, 1778). Risso indicated no type species for *Eulima*. His generic name was readily adopted and at first was used to embrace all the 'normal' eulimids (i.e. excluding the umbilicated species placed in *Niso*, and the little-known 'styliferids'). Later the name was used in two different senses, according to which of Risso's species was accepted as the type.

Leach's (1847) 'Classification of the British Mollusca' was published posthumously by Gray. Three nominal species of *Balcis* were listed there but, of those, two are nomina nuda. The third species, *B. montagui*, defined by its synonym, '*Helix polita* Montagu' (= *Melanella alba* (da Costa)), is the type of *Balcis* by monotypy, notwithstanding the designation of '*Helix subulata*' as type by Gray later in 1847 (Warén 1992b). The fixation of *Balcis montagui* as the type species of *Balcis* was ratified by ICZN Opinion 1739 (1993). Consequently *Balcis* may be used (herein as a subgenus of *Melanella*) for those species around *Melanella alba* (da Costa, 1778), the oldest available name for *Helix polita* Montagu. The status of *Balcis* in relation to *Melanella* is still unclear, but it may provisionally be regarded as of subgeneric rank. Warén (1984) admitted that *Balcis* can hardly be separated from *Melanella* s.s., but is characterized by having a very fine, reticulated microsculpture, a large size (i.e. in relation to *Vitreolina* species), and an almost straight outer lip. Like *Melanella* s.s. it is parasitic on holothurians in those species where the host is known.

*Leiostraca* Adams & Adams, 1853, was introduced to accommodate those eulimids with somewhat flattened, rather than rounded, whorls and with incremental scars on each side, instead of on one side of the whorls only, as in 'typical' species of *Eulima*. *Turbo subulatus* Donovan (= *Eulima glabra* (da Costa)) was selected as type by Bucquoy *et al.* (1883), who similarly recognized two divisions of *Eulima*, those with a horizontal suture between the whorls (= *Eulima* s.s.) and those with an oblique suture (*Leiostraca*). In doing this they were explicitly restricting *Eulima* s.s. to the group of species which included '*Eulima polita*' as well as the smaller, curved species now placed in *Vitreolina*. They accepted *E. polita* (Linnaeus) as type invalidly, as it was not one of Risso's original species, because they believed this was Risso's first species, *E. elegantissima*. Gray had selected '*Helix polita*' as type of *Eulima* in 1847 and, although that type designation is equally invalid, it does indicate that Gray was using the name *Eulima* as an exact equivalent of *Balcis*. He probably regarded '*polita*' (sensu British authors) and Risso's *glaberrima* as the same species. Herrmannsen, earlier in 1847, had designated *Turbo subulatus* Donovan as type of *Eulima*, and this alternative interpretation, which made *Eulima* s.s. and *Leiostraca* synonyms, also had its advocates. Doubt remained, however, about the validity of this designation too, as it was not certain whether Donovan's *T. subulatus* was the same nominal species as that originally included by Risso as '*Eulima subulata* Brocchi'. This question was not finally resolved until the ICZN upheld Herrmannsen's designation of *T. subulatus* Donovan in Opinion 1718 (1993). Despite the uncertainty over its type species, *Eulima* was used as the major genus of the Eulimidae for more than a century, with almost all authors naming the slender, white eulimids as species of that genus. Species of *Eulima* have a radula and are parasitic on ophiuroids (Warén 1984).

*Subularia* Monterosato, 1884, was introduced to replace *Leiostraca* Adams & Adams, 1853, in the belief that *Leiostraca* was preoccupied by *Leiostracus* Albers, 1850 [Bulimulidae]. Although a one-letter difference is now sufficient to prevent such homonymy of generic names, Monterosato's view was that prevailing at the time, and accounts for the considerable usage of *Subularia* at least as a subgenus. It is an objective synonym of *Eulima* and *Leiostraca*.

*Polygireulima* Sacco, 1892, was introduced for a group of Italian Tertiary eulimids, and has subsequently been treated as a replacement for the preoccupied *Acicularia* Monterosato, 1884, with *Eulima intermedia* Cantraine, 1835, cited as type. Warén (1984) discussed the



taxonomic problems surrounding the use of *E. intermedia*, and chose to identify that species in the sense of *Rissoa sinuosa* Scacchi, 1836, citing *R. sinuosa* as type of *Polygireulima* 'because the name *intermedia* has been used in so many senses, the types are lost, the description unintelligible, and a future restriction of the name will make the confusion still greater'. Subsequently both *Eulima intermedia* Cantraine and *Rissoa sinuosa* Scacchi were made objective synonyms of *Turbo politus* Linnaeus in Opinion 1780 (1994) by the acceptance of the same neotype specimen for all three species as designated by Warén (1988).

Warén (1984) seems to have been misled by earlier citations of *E. intermedia* as the type of *Polygireulima*, as he states: 'Although [Sacco] was aware of the name *Acicularia*, he never suggested that it should be replaced. Because of this I do not understand why he introduced *Polygireulima*, but as Monterosato's name is preoccupied, I shall follow later authors . . . who, being aware of the homonymy of *Acicularia*, used *Polygireulima* with *E. intermedia* as type species.' This cannot be correct, as Sacco introduced his new subgenus precisely because of the uncertainty about Cantraine's species. He said [my translation of Sacco (1892)]: 'As *Eulima intermedia* Cantraine (type of subgenus *Acicularia*) was not figured by its author and has been variously interpreted by malacologists, this subgenus is not well defined, and therefore it is with some doubt that the following fossil species are referred to it. . . . If then one recognizes the need to separate the forms having as type *Eulima spina* Grateloupe, whether from *Eulima* s.s., or from *Subularia* and *Acicularia*, they must be placed in a new subgenus somewhat close to *Margineulima*, and which I name *Polygireulima* Sacco, 1892.' From this it is evident that the type must be the Miocene fossil species *E. spina* Grateloupe, 1838, and not *E. intermedia*, but this does not necessarily affect the usage of the name.

*Polygireulima* is somewhat intermediate between *Melanella* and *Eulima*, as the completely smooth shells have a high aperture, slightly flattened whorls, a straight spire and intermittent incremental scars. Smith & Heppell (1991) treated it as a full genus, on the advice of Warén, but Sabelli *et al.* (1990) included the same species (*polita* and *monterosatoi*) in *Melanella*, and Warén & Gittenberger (1993), in their application to the ICZN to ratify the neotype designation of *Turbo politus*, cited its currently valid name as *Melanella polita* without mention of *Polygireulima*. *Polygireulima* is retained herein as a subgenus of *Melanella*. Its hosts are unknown, but are presumed to be echinoderms.

*Vitreolina* Monterosato, 1884, is currently used for a speciose group of small eulimids, which are parasitic on a wide variety of echinoderm hosts worldwide. The spire is curved, oval in cross-section, and has sutures with a pronounced downward curve to meet the incremental scar on each whorl. The type species, by subsequent designation by Bucquoy *et al.* (1898), is *Eulima incurva* (Renier) [i.e. Brusina, 1870] = *Eulima philippi* Rayneval, Hecke & Ponzi, 1854 (see discussion under *Helix incurva* Renier, 1804, above).

With the recognition of the overall priority of *Melanella*, and the status of other formerly problematical names determined by Warén (1984, 1988, 1989, 1992a, b) and ratified by ICZN Opinions 1718 and 1739 (1993), the current status of the commoner European littoral genera is as follows:

*Melanella* Bowdich, 1822 (including *Balcis* and *Polygireulima*): type species *Melanella dufresnii* Bowdich, 1822.

*Eulima* Risso, 1826 (= *Leiostraca* and *Subularia*): type species *Turbo subulatus* Donovan, 1804 (= *Strombiformis glaber* da Costa, 1778).

*Vitreolina* Monterosato, 1884: type species *Eulima incurva* Brusina, 1870 (= *Eulima philippi* Rayneval, Hecke & Ponzi, 1854).

*Niso* Risso, 1826, was originally established for the sole species *N. eburnea* Risso, 1826, the exact identity of which is still conjectural (see discussion of *Helix terebellata*: Brocchi 'above') but, although placed by Risso among the Turridae, *Niso* was later recognized as allied to *Eulima*. It has been consistently used for both Recent and fossil species with high, conical shells, usually brownish in colour or marked with brown bands, and with a broad, deep,



funnel-shaped umbilicus, often penetrating the entire length of the spire. Many species have a sculpture of widely-spaced longitudinal raised lines, running straight from suture to suture, and a strong basal keel around the umbilicus is another common feature of the genus. Little is known of their habits; they possess a radula and at least one species has been reported as parasitic on a starfish (Warén 1984).

The other group of species segregated at an early date from 'typical' eulimids were the 'styliferid' species with shells terminating in a styloid or papilliform apex. Apart from *Helix corallina* Chemnitz, 1788 (see above), the first to be described was *Phasianella stylifera* Turton, 1825, found attached to the spines of *Echinus*. This was moved to *Velutina* by Fleming, 1828, who, not completely happy with that placement either, also proposed the conditional generic name *Stylina*, which unfortunately is preoccupied for a coral, *Stylina* Lamarck, 1816. The new genus *Stilifer* Broderip, 1832, was established for two new species, *S. astericola*, parasitic on a starfish from the Galapagos Islands, and *S. subulatus* which is Chemnitz's *H. corallina*. At the same time, Broderip also included Turton's species, renaming it *Stilifer turtoni* to avoid tautonymy between the generic and specific names. Later in 1832 Broderip republished his new genus in Sowerby's *Genera of Recent and fossil Shells*, but this time, whether by misprint or intention, the name was spelled *Stylifer*. For some reason, perhaps because it was assumed to be a deliberate emendation, or maybe Sowerby's work was more accessible than the Zoological Society's *Proceedings*,<sup>21</sup> in which the name *Stilifer* was first published, the later incorrect spelling enjoyed far greater usage than the original correct one. *Stilifer* is now restricted to those species which are parasites of starfish, forming cysts or galls deep in the body wall. The ectoparasites of regular echinoids, such as Turton's species, are now placed in *Pelseneeria* Koehler & Vaney, 1908.

## TAXA OF THE FAMILY GROUP

The eulimids were finally removed from the Pyramidellidae in 1853. Adams & Adams are usually credited with establishing the two separate families, Eulimidae (for *Eulima*, *Niso* and *Leiostraca*) and Styliferidae, in the first volume of their *Genera of Recent Mollusca* in the December of that year. In the same year, Philippi, in his *Handbuch der Conchyliologie und Malacozoologie*, established the same two families (although the included genera differed from those of the Adams brothers), under the names Eulimacea and Stylinacea. The exact date of Philippi's work has not been determined but, as it was reviewed in May, 1853 (Warén 1992c: 179), it must have already been published by that date. Ponder & Warén (1988) attributed the family name Eulimidae (as Eulimacea) to Troschel, 1853 (and at the same time attributed the superfamily name Eulimoidea to Adams & Adams, 1854, incorrectly, as both family and superfamily names must have the same author and date). Troschel's work may be prior to those of Philippi and Adams & Adams but, although we may guess it was published about April, 1853, it cannot take priority over Philippi until a more precise date can be ascertained.<sup>22</sup> The name Eulimidae must, therefore, date provisionally from Philippi, 1853.

<sup>21</sup> Not the *Proceedings of the Zoological Society of London*, as cited by Warén (1984), but vol. 2 of the *Proceedings of the Committee of Science and Correspondence of the Zoological Society of London*, two volumes of which were published before the first volume of the *P.Z.S.* proper.

<sup>22</sup> Troschel contributed an annual review of malacology ('Bericht über die Leistungen im Gebiete der Naturgeschichte der Mollusken') to the *Archiv für Naturgeschichte*, the second 'Band' of each 'Jahrgang' of which was in effect a forerunner of the *Zoological Record*. In this he grouped the entries under family names for the first time in 1852, where he included the eulimids in the Pyramidellidae, but the following year, in his review for 1852 (*Arch. Naturgesch.* 19 (2): 90–140) he introduced the family-group name Eulimacea on p. 112. Three 'Hefte' of each 'Band' were published each year. Troschel's paper is in the first 'Heft' and was probably published sometime in April.

Stylinacea Philippi is invalid as its type genus, *Stylina*, is a junior homonym, so Stiliferidae (correction of Styliferidae) can be attributed to Adams & Adams. Grusov (1965), however, considered that recognition of more than one taxon at family level within the Eulimacea was not warranted. Warén (1984) concurred, and consequently synonymized not only the Stiliferidae but also the highly modified endoparasitic family Entoconchidae with the Eulimidae, together with several other family-group taxa which had been segregated by various authors. The only other family provisionally retained in the same superfamily was the Aclididae, which is still of uncertain affinities.

With the recognition of the priority of *Melanella* over *Eulima*, and of the incorrect usage of *Strombiformis* in place of *Leiostraca* or *Subularia*, a number of authors<sup>23</sup> substituted Melanellidae or Strombiformidae for Eulimidae, on the grounds that the type genus was a junior synonym. Although it has never been a requirement of the Code of zoological nomenclature to change a family name for that reason, it was common practice to do so. The present Code (Article 40b) allows for the maintainance of such a replacement name if it has won general acceptance. Strombiformidae was used as the name of this family by the *Zoological Record* from 1917 to 1938 and Melanellidae is still in regular use, especially in palaeontological works, but these alternative names have certainly not won general acceptance, as Eulimidae has had a continuous usage alongside them. Eulimidae Philippi, 1853, is accordingly the valid name for the single family recognized by Warén (1984), to includes all known eulimacean genera other than the Aclididae.

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# *ANNULOBALCIS AURISFLAMMA*, A NEW SPECIES OF EULIMIDAE (GASTROPODA, PROSOBRANCHIA) PARASITIC ON A CRINOID FROM BRAZIL

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**Abstract:** A new species of Eulimidae, *Annulobalcis aurisflamma*, an ectoparasite on the crinoid *Tropiometra carinata* (Lamarck, 1816) is described from the Ubatuba coast, São Paulo, Brazil. Diagnostic anatomical characteristics of this species include the mantle colour, female period with penis persistence and a dorsal projection of the inner wall of proboscis, near the proboscis opening.

**Key words:** *Annulobalcis* Prosobranchia, Eulimoidea, Anatomy, Ectoparasitism, *Tropiometra carinata*, Crinoidea, Brazil.

## INTRODUCTION

The genus *Annulobalcis* Habe, 1965 was hitherto unknown from the Atlantic Ocean. Warén (1983) examined several species of this genus, but in the literature only 3 species of *Annulobalcis* have been described: *A. shimazui* Habe, 1965 (type species), *A. yamamotoi* Habe, 1974 (both from Japan) and *A. marshalli* Warén, 1981 (from New Zealand). In the last species the cephalo-pedal complex was figured. In this paper *Annulobalcis aurisflamma*, an ectoparasite of the crinoid *Tropiometra carinata* (Lamarck, 1816), is described from the São Paulo coast, Brazil. A brief anatomical description is included, the first such data for any member of this genus.

## MATERIALS AND METHODS

The studied material, now deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP), was collected by diving in October and November 1991 at Ubatuba, the north coast of São Paulo State, at two sites: (1) 23°29'S 45°05'W, Enseada Beach, north coast, depth: intertidal to 5m; (2) 23°33'S 45°04'W, south beach, Anchieta Island, depth: intertidal to 8m. About 100 specimens were collected. Two additional specimens were collected at Praia Grande (south coast of São Paulo).

The removal of the crinoids from their shelters was necessary to find the snails. The collected gastropods were put in a transparent flask with seawater for behavioural observations; after a few hours they were fixed in 70% ethanol. The shells of specimens studied anatomically, were decalcified in Railliet-Henry fluid and examined directly; afterwards, they were dehydrated in ethanol, dyed in carmine, fixed and cleared in creosote.

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Some serial sections of 7 to 15  $\mu\text{m}$  were made, dyed by H.E. (Fig. 15). SEM photographs were taken in the Laboratório de Microscopia Eletrônica do IBUSP.

The crinoid identification is based on Tommasi (1957 and 1965). The systematic and anatomical terminology follow Warén (1981 and 1983), and Lützen (1972).

## SYSTEMATIC DESCRIPTION

### Family Eulimidae

Genus *Annulobalcis* Habe, 1965

*Annulobalcis aurisflamma*, sp. nov.

(Fig. 1 to 25)

*Material Examined*: holotype: MZUSP 27905; paratypes: MZUSP 27906, (1 specimen) MZUSP 27907, (1 specimen); MZUSP 27908, (1 specimen); MZUSP 27910, (1 specimen); MZUSP 27938, (10 specimens); all from type locality. MZUSP 27909, (1 specimen); MZUSP 27939, (10 specimens); both batches from the Anchieta Island site. Museu Nacional do Rio de Janeiro Col. Mol. MNRJ 6374 and MNRJ 6375, (2 specimens from type locality). Museu Oceanográfico da Fundação Universidade de Rio Grande MORG 29681 and MORG 29682, (2 specimens from type locality). Swedish Museum of Natural History SMNH Inv. Type Coll. 4511, (2 specimens from type locality). MZUSP 27974, (2 specimens, São Paulo, Praia Grande City, Fortaleza de Itaipu coast, 2 m deep, Nov 1993). USNM 860590 (2 specimens from type locality)

*Type Locality*: Brazil, São Paulo State, Ubatuba City, Enseada Beach, 23°29'S 45°05'W.

*Diagnosis*: Transparent shell, colour given by the tegument; mantle brown with 5 to 8 axial yellow stripes; minute snout; dorsal inner projection of proboscis near the proboscis opening, absence of muscular pumps; protandric hermaphroditism, female stage with penis remaining. Penis with irregular arrow-like projection at tip.

*Shell*: small (to 11mm), slender and pointed (apical angle about 35°), up to 10 distinctly convex whorls, thin, transparent, colourless (Figs. 1, 3, 4). Protoconch of 3 glassy, smooth, convex whorls; axis of protoconch slightly deviating from the axis of the teleoconch. (Fig. 2). Teleoconch up to 6 convex glassy whorls, with a conspicuous suture. Sculpture of extremely fine spiral and axial striae, only visible with stereomicroscope; spiral striae may be absent or vary from 1 to 6 per whorl; axial striae very numerous (with the SEM this sculpture is scarcely visible, except for a short portion near the suture) (Fig. 1c)). Elliptical aperture, sigmoid inner lip, reflected outer lip (Fig. 5). Columella sigmoid.

*Operculum*: elliptical, corneus, yellowish-transparent, thin. Subterminal nucleus (Figs. 6, 17). Occupies the whole aperture.

*Mantle*: visible through the transparent shell, reddish-brown in colour, with 5 to 8 wide, irregular, yellow axial stripes on the last whorl. These axial stripes are arranged directly below the ones of the preceding whorl, giving the effect that some stripes begin at the apex and finish at the base of the shell. Some specimens also have 1 to 3 similarly coloured spiral stripes in the lower half of the body whorl (Figs. 3, 4, 5). The penultimate whorl has a deep narrow axial furrow in preserved specimens (Fig. 7 and 16). Mantle edge simple, without siphon (Figs. 7 and 21).

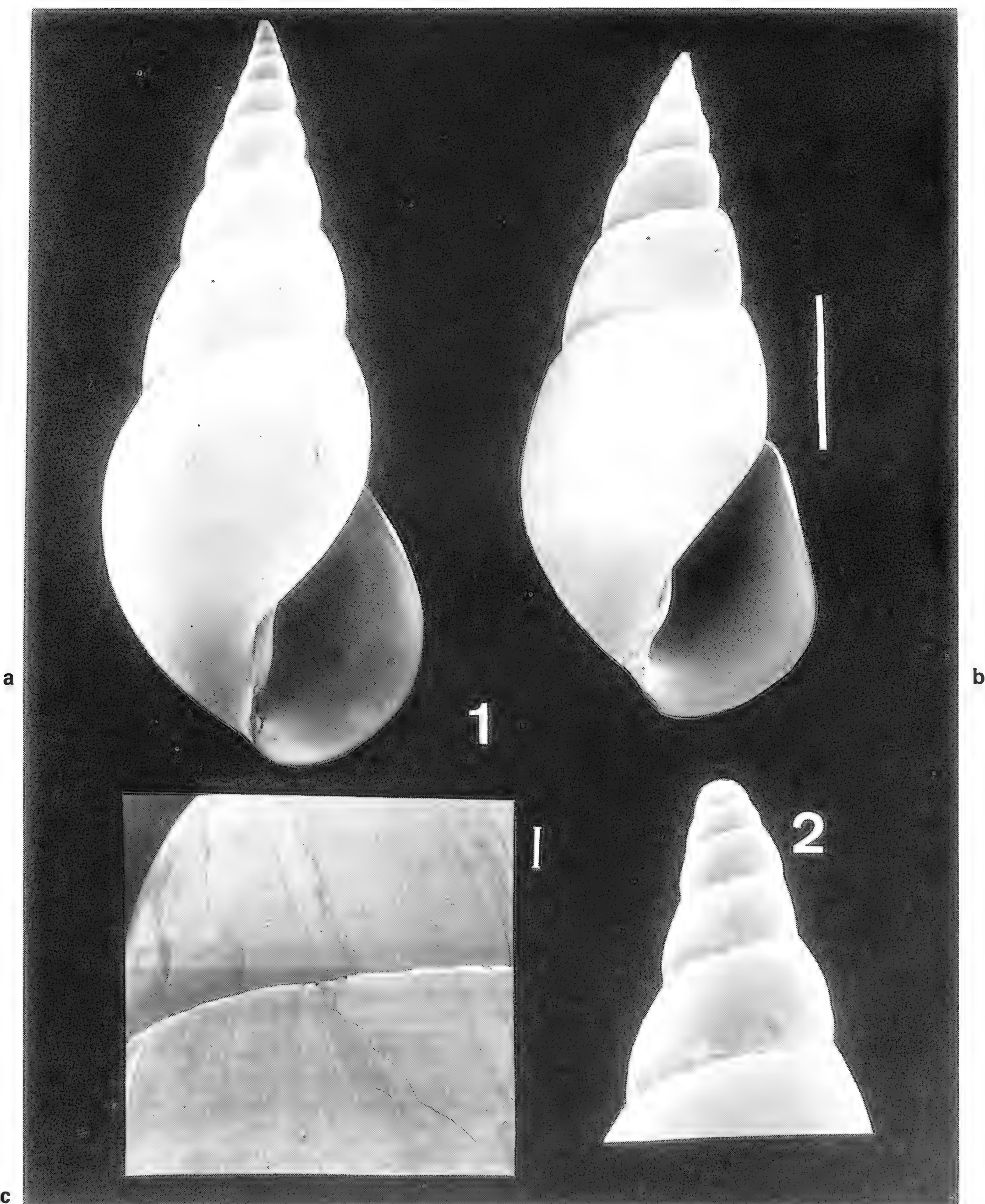
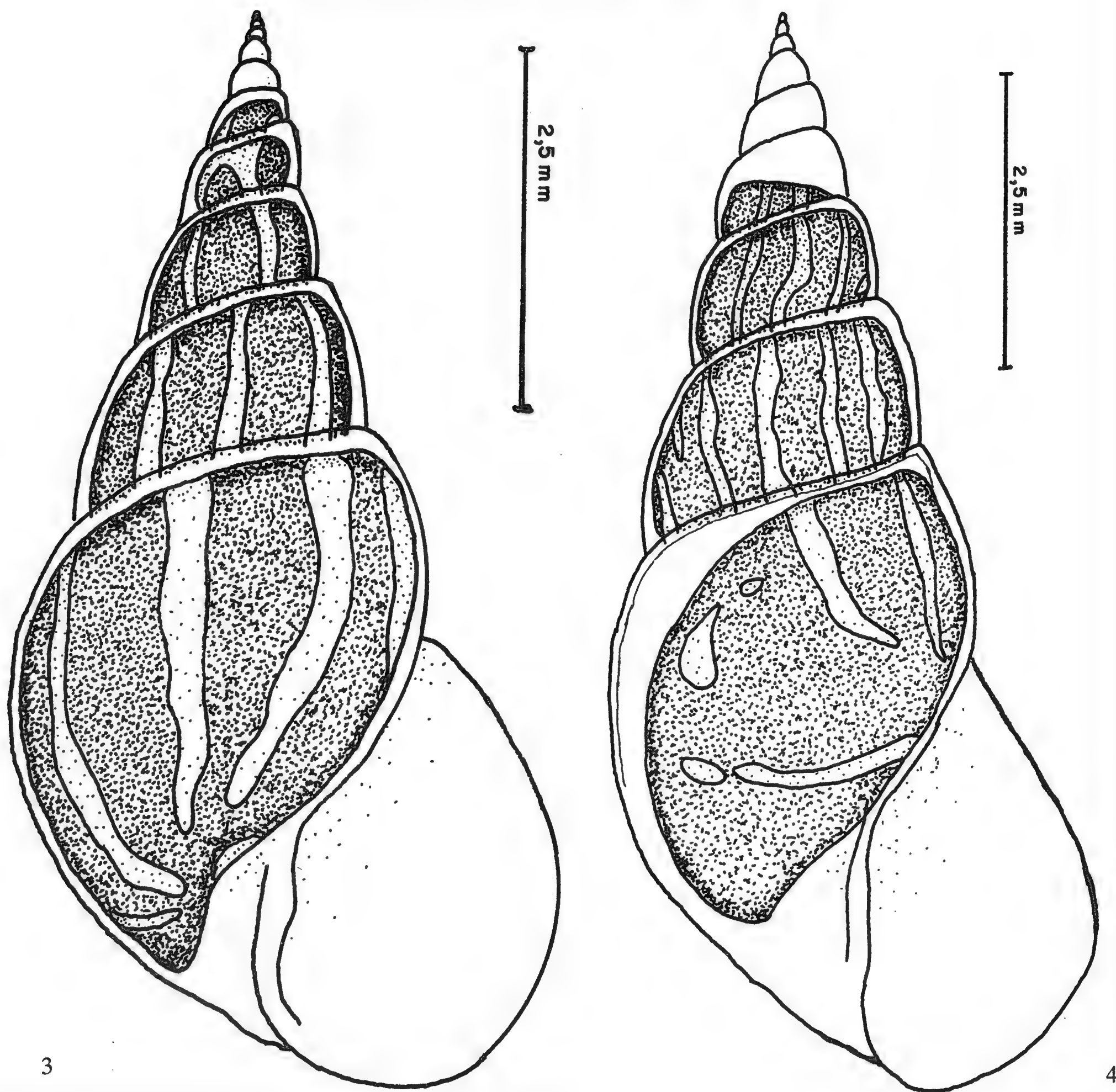


Fig. 1. *a*, and *b*, frontal view of the shell of two specimens, scale = 1 mm; *c*, detail of the shell surface of *a*, scale = 0.2 mm.

Fig. 2. Detail of protoconch and two teleoconch whorls, in profile, scale = 0.1 mm





Figs. 3 and 4. Shell and mantle colour variation, 2 females

*Head-foot complex*: basic colour reddish-brown with yellow band on tentacles and foot margins. Tentacles fused centrally (Figs. 7, 8); a dark sphaerical eye on outer base of each tentacle, with an elevation of tegument around of each eye (Fig. 20). The lens is hollow. Penis always present, attached beside the right tentacle. Snout small and conic. Foot well-developed, long, divided into propodium, mesopodium and metapodium (Figs. 7, 8A). The foot has a slight constriction between the anterior and the mid regions and a median longitudinal, narrow furrow (Fig. 8B). Pedal gland well-developed, causing a swelling behind and to the right of the head. In section this gland has a central duct, that opens in the anterior region of the sole furrow (Fig. 14). No other pedal gland was found.

*Pallial complex*: rather-deep mucous-filled pallial cavity (1 whorl), posterior part covered by the anterior part of the kidney (Figs. 10, 16); in the female it is mainly occupied by a large oviduct (Fig. 21). Hypobranchial gland well-developed and pyriform. Gill long with



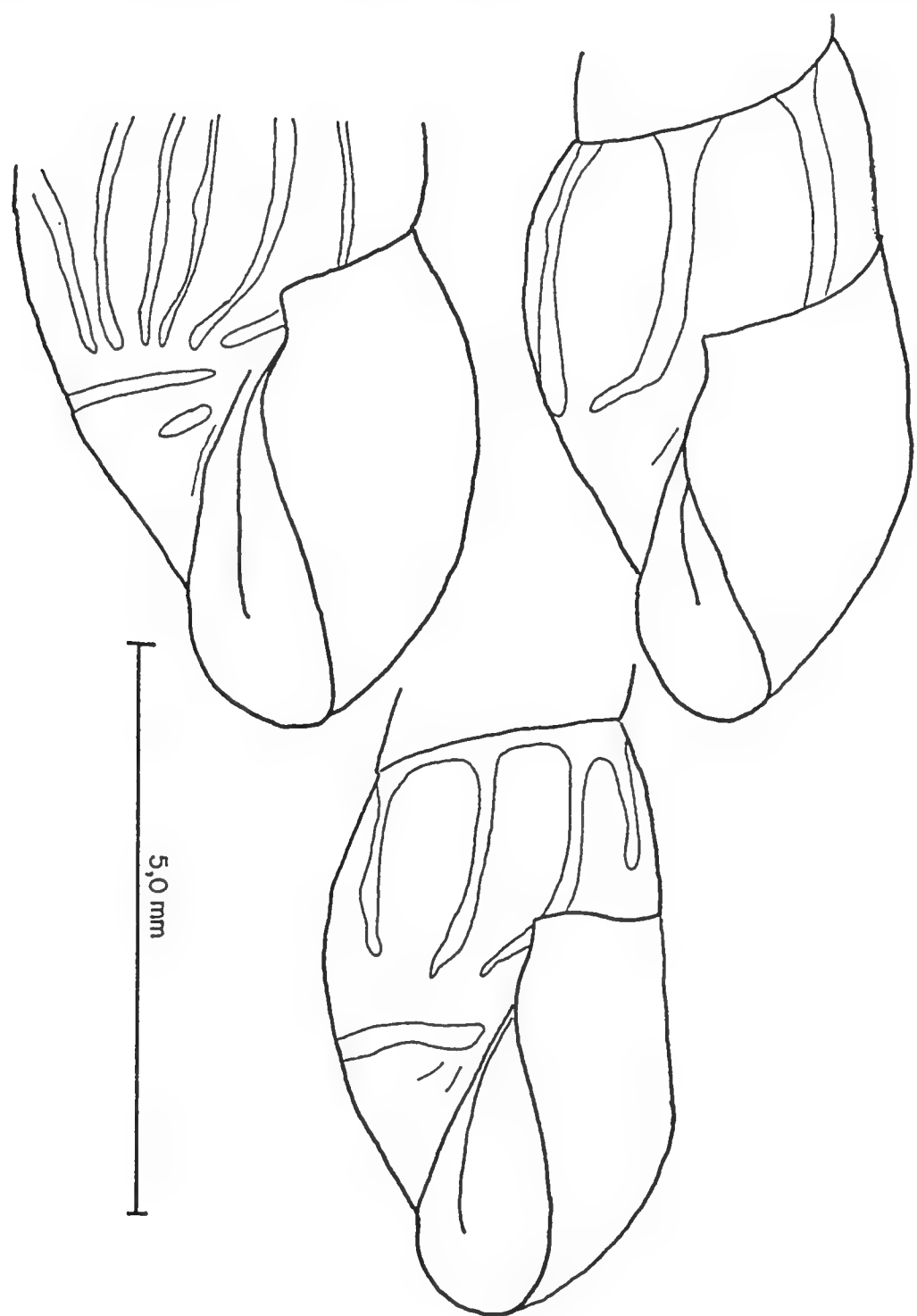


Fig. 5. Outer lip and mantle colour variation of three females

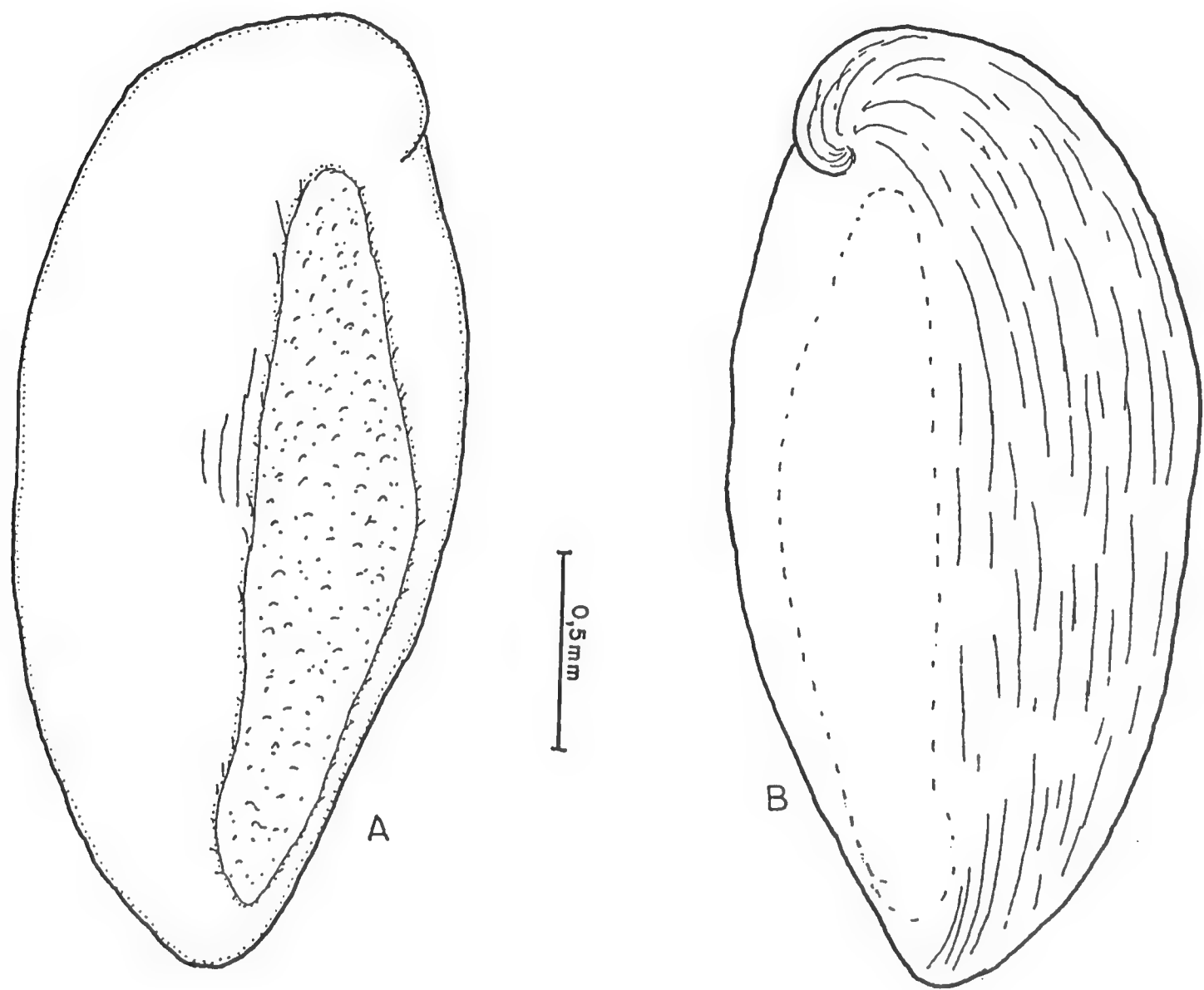


Fig. 6. Operculum: A: inner view; B: outer view

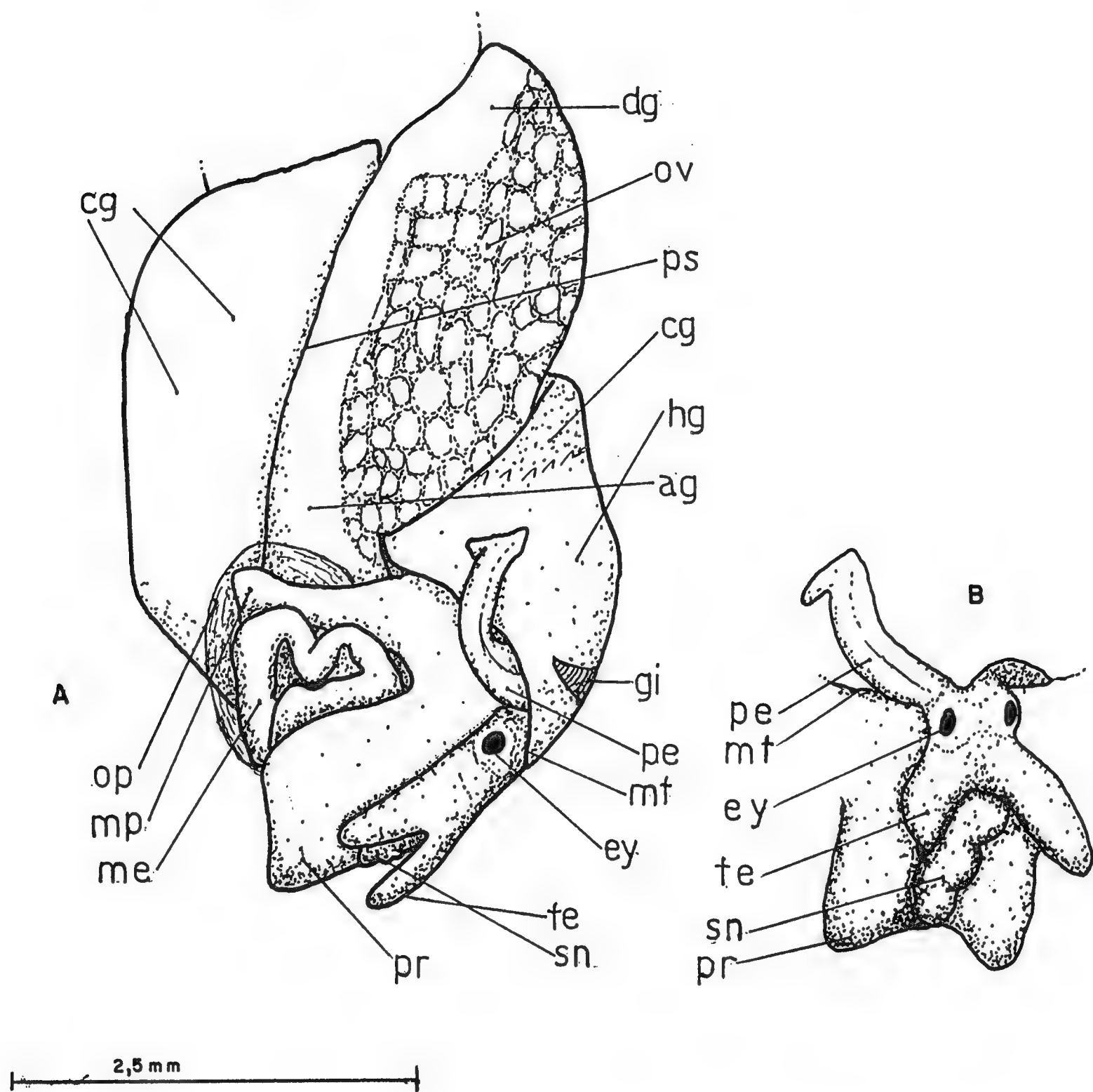


Fig. 7. Topography and outer morphology of a female. A: lateral view; B: frontal view of head-foot

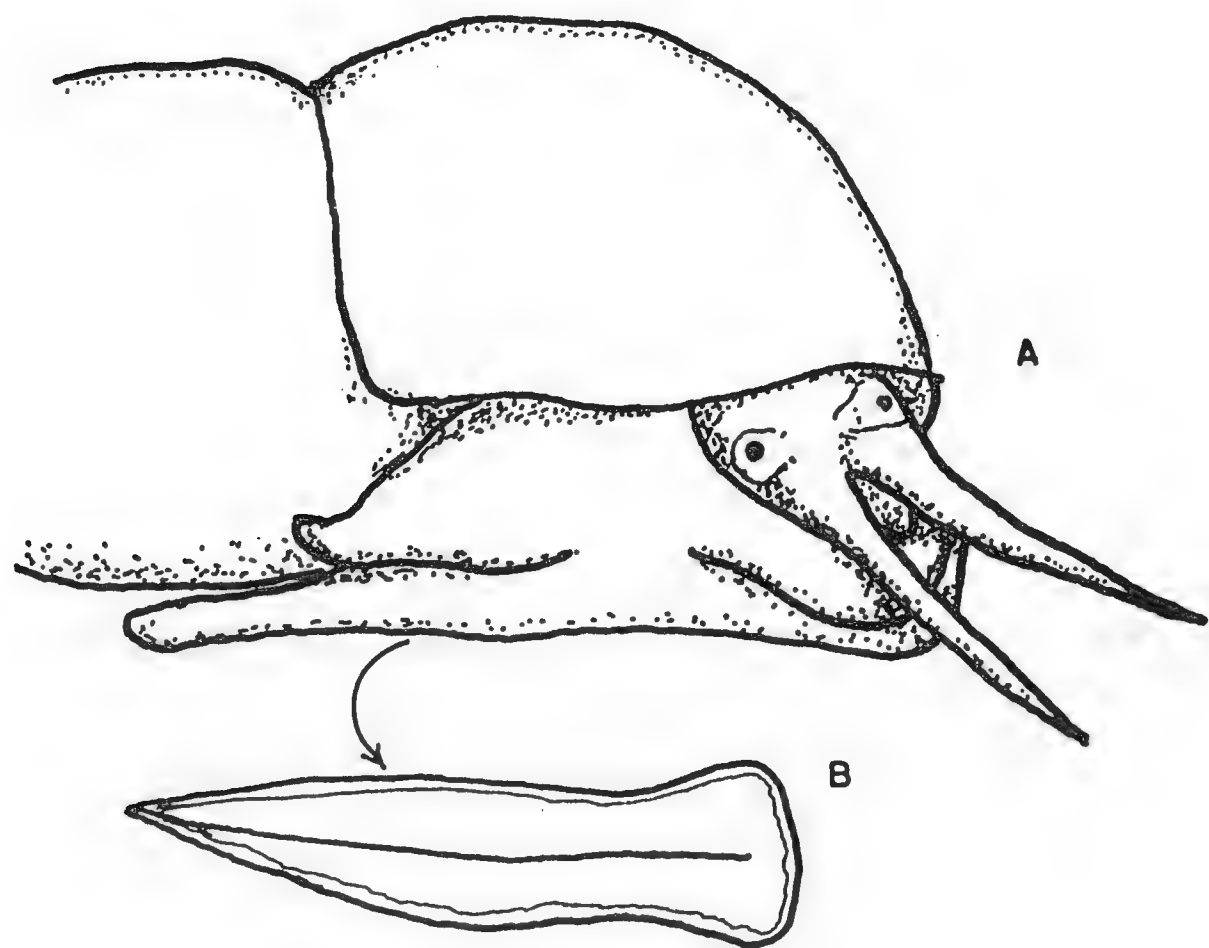


Fig. 8. Crawling specimen. A: latero-frontal view; B: ventral view of mesopodian sole, moving on a glass, anterior region at right

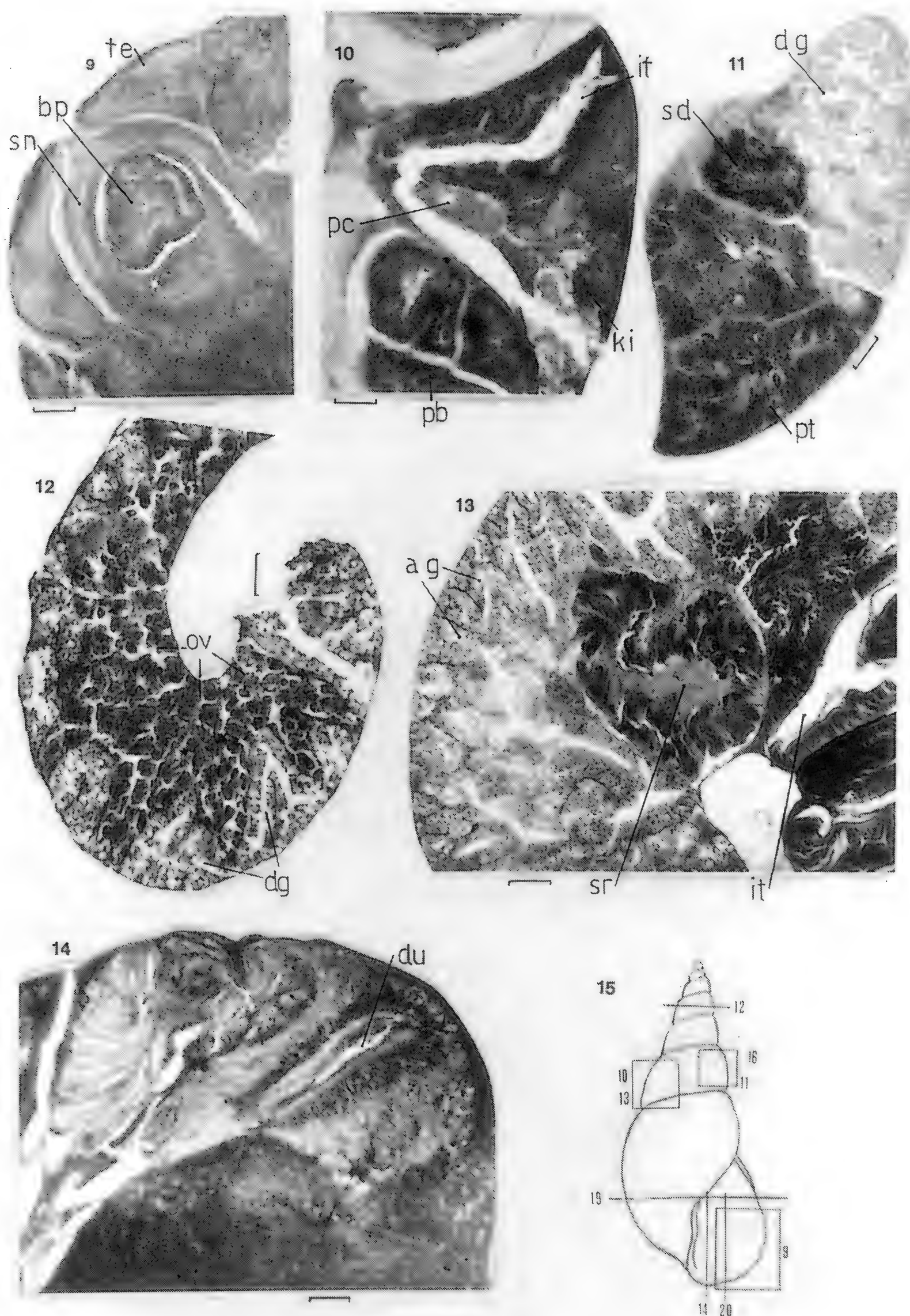


Fig. 9. Axial section in snout region. HE, 15  $\mu$ m

Fig. 10. Axial section, beginning of last whorl. HE, 15  $\mu$ m

Fig. 11. Axial section, beginning of penultimate whorl in male. HE, 15  $\mu$ m

Fig. 12. Transverse section of first whorls in female. HE, 7  $\mu$ m, the same specimen of Fig. 19

Fig. 13. Axial section, beginning of penultimate whorl in female. HE, 7  $\mu$ m

Fig. 14. Transverse section just over the foot. HE, 7  $\mu$ m

Fig. 15. Schematic representation of approximate section level of Figs. 9 to 20. Scales Figs. 9 to 14 = 0.1 mm



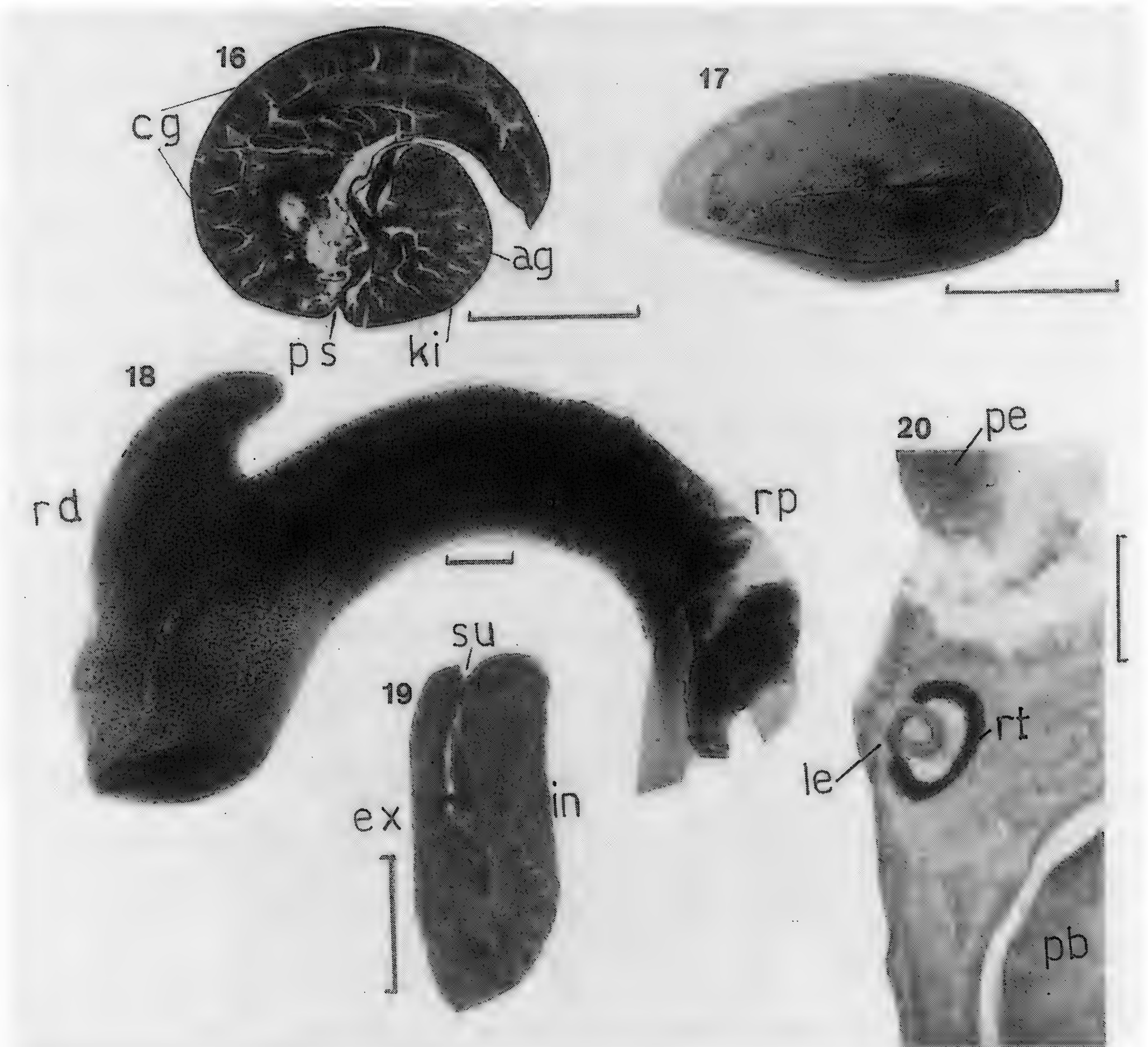


Fig. 16. Transverse section, penultimate whorl in female. HE, 7  $\mu$ m

Fig. 17. External view of operculum, scar view. Congo red

Fig. 18. Total outer view of cleared penis. Carmin

Fig. 19. Transverse section of basal region of penis. HE, 7  $\mu$ m

Fig. 20. Transverse section of head, on the right eye. HE, 7  $\mu$ m Scales Figs. 16 and 17 = 1.0 mm; Figs 18 to 20 = 0.1 mm

transverse leaflets, blunt anteriorly, leaflets pointing posteriorly. Osphradium narrow and long. Pericardium shown in Fig. 10.

*Digestive system:* proboscis opening located at anterior extremity of the snout, rounded anteriorly and blunt posteriorly (Fig. 22). There is an inner projection of the dorsal wall of proboscis, adjacent and dorsal to the proboscis opening (Figs. 22 and 23). Its surface is irregular, and inner tissue muscular (Fig. 9). Proboscis of acrembolic type, long and thick (Fig. 22), without internal structures except the anterior projection. Oesophagus long and slender, anteriorly united with adjacent wall by thin muscle fibres (Fig. 22). Rest of digestive

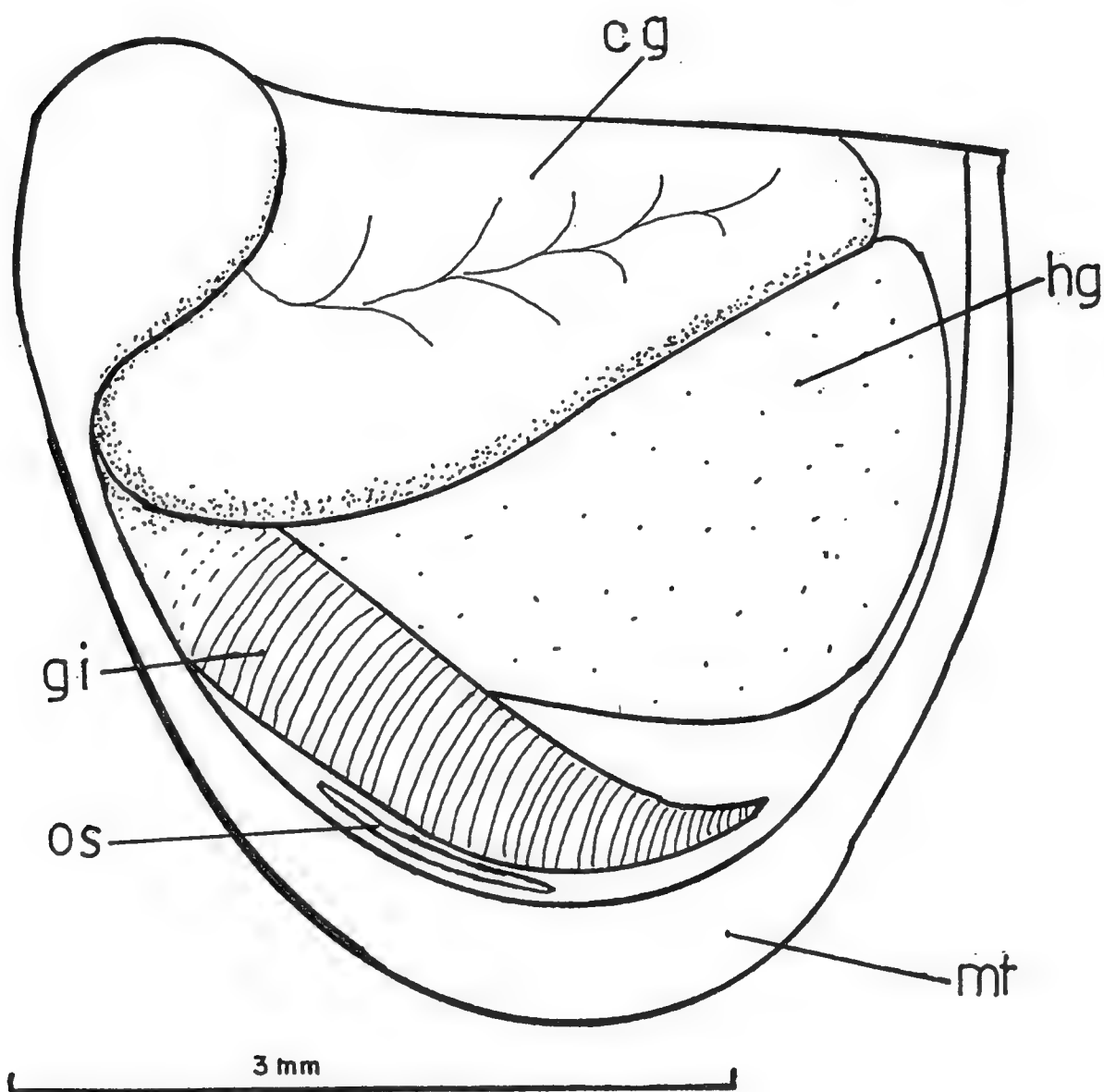


Fig. 21. Schematic view of the pallial organs in female, inner view

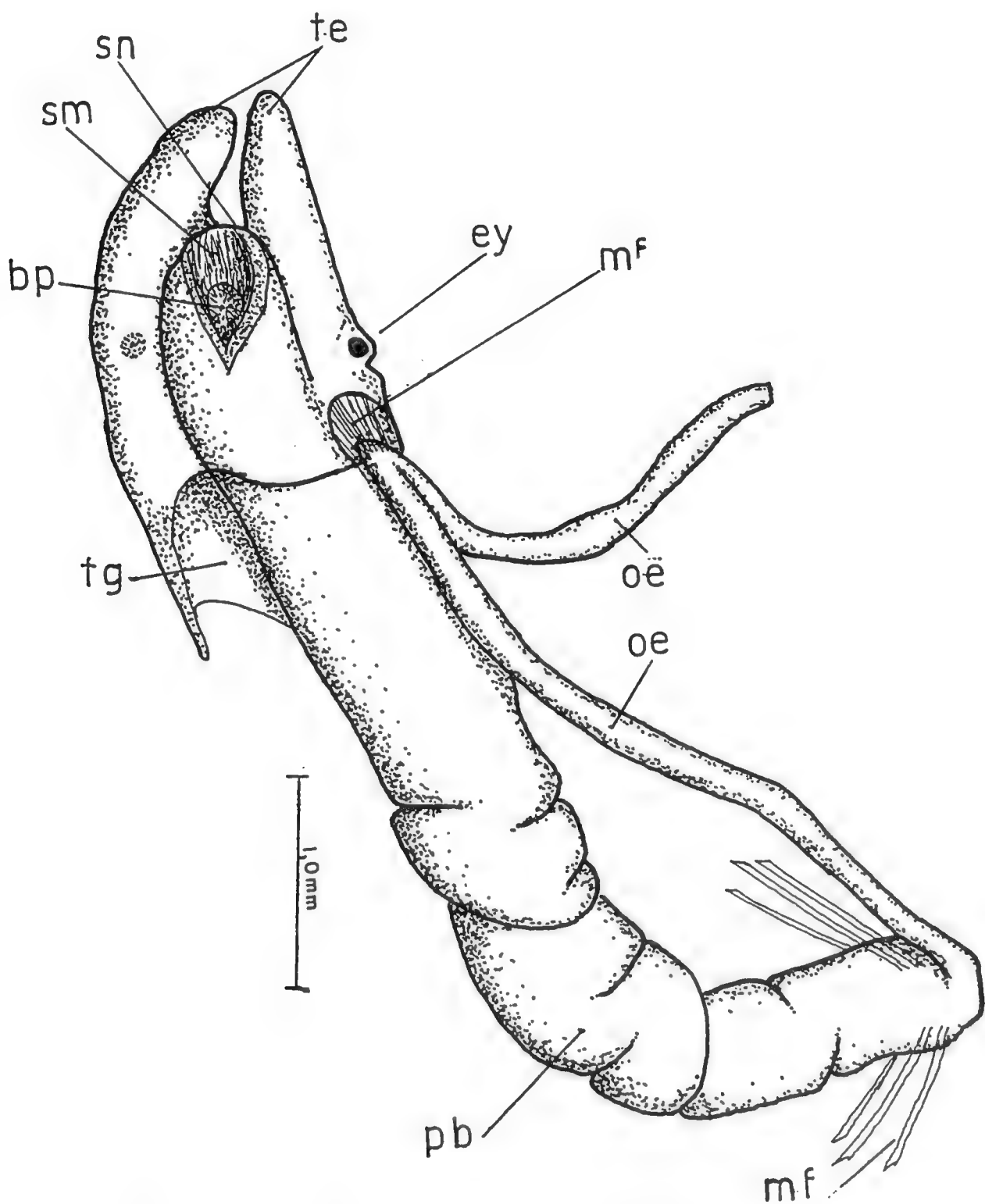


Fig. 22. Ventral view of head and anterior region of digestive system

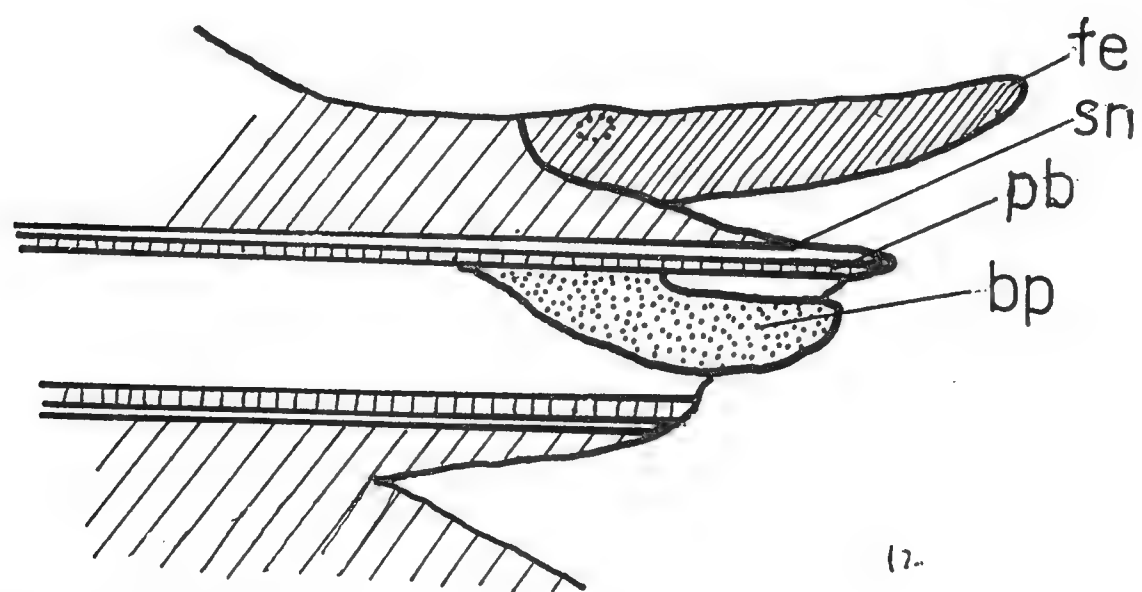


Fig. 23. Schematic representation of a sagittal section of head

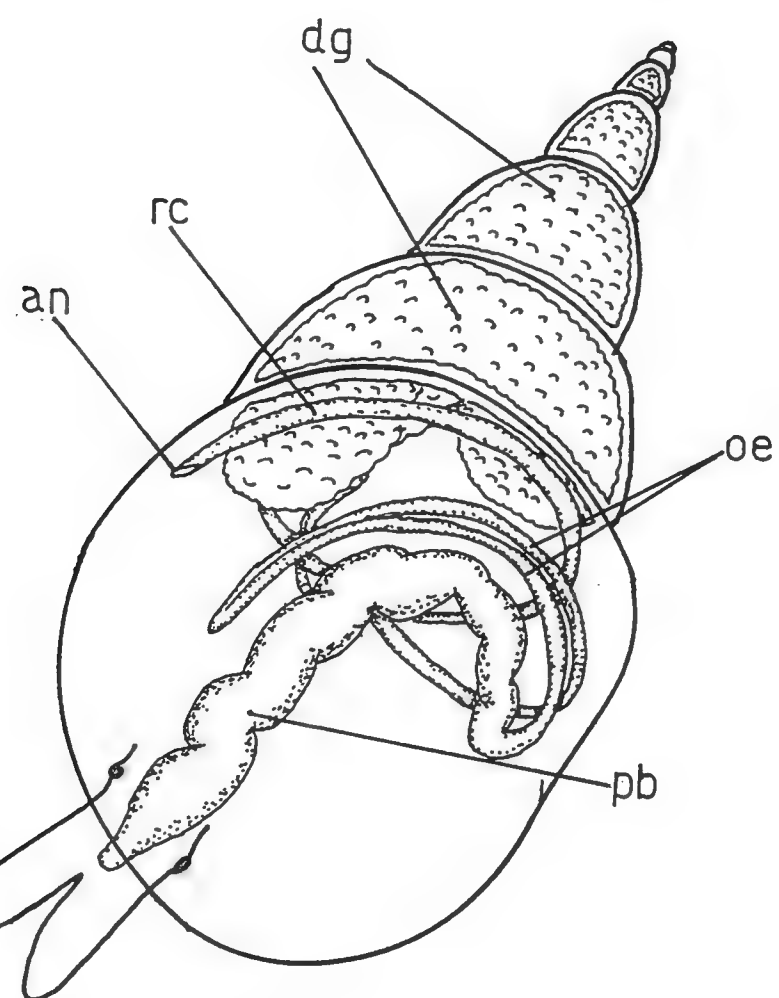


Fig. 24. Schematic representation of digestive system

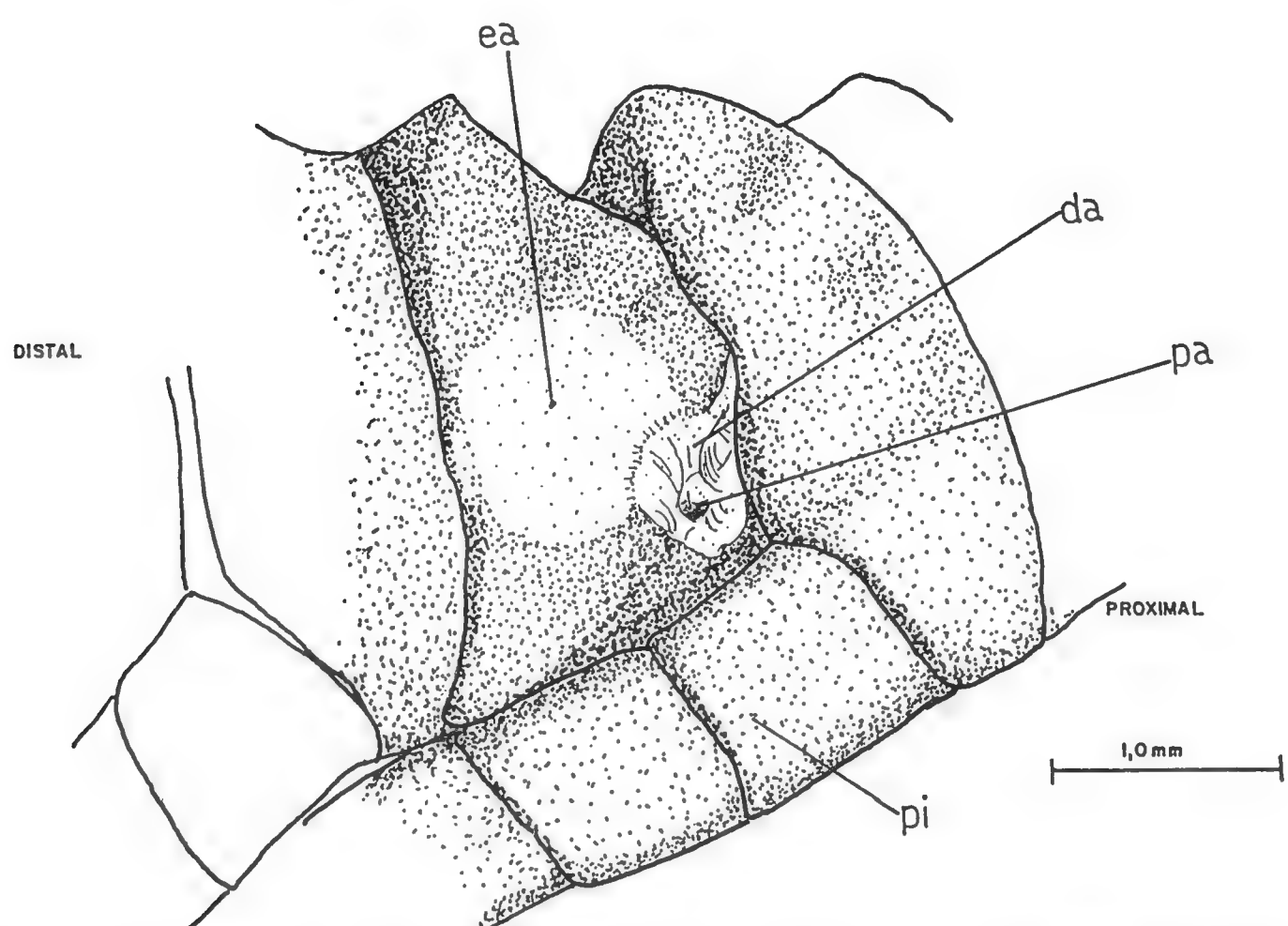


Fig. 25. Scar left by *A. aurisflamma* on the aboral-proximal face of the arm of *Tropiometra carinata*



tube and digestive gland present, but radula, pumps and developed stomach are lacking (Fig. 24).

*Genital system:* sex only determined from serial sections (and presence of developed pallial oviduct) since all specimens have penis. The largest specimens have ovarian and the smallest have testicular gonads, suggesting protandric hermaphroditism. Undifferentiated or simultaneously hermaphroditic gonad was not found.

*Male:* testis lies close to the columella, occupies 3 to 4 whorls in length, in the penultimate whorl it involves 1 to 3 small glands (prostate – Fig. 10, and also probably immature female glands). Seminal vesicle well-developed (Fig. 11). Penis long and flattened, with an expanded, irregular, arrow-shaped tip (Fig. 7 and 18) transverse section of basal region of penis (Fig. 19) shows a deep sperm gutter, and no inner duct. No duct uniting the penis and genital glands was found.

*Female:* penis present, similar to that of males (Fig. 7). The ovary occupies most of the whorls, with projections through the digestive gland (Fig. 12). Seminal receptacle developed (Fig. 13). Albumen gland shown in Fig. 13. Capsule gland large and conic (Fig. 21), with a central main channel (Fig. 16); the capsule gland sometimes contains, several small, sphaerical white eggs.

*Measurements:* holotype: length: 8.7 mm, width: 3.3 mm. Paratypes: MZUSP 27906:  $9.6 \times 4.5$  mm; MZUSP 27905:  $8.8 \times 3.8$  mm; MZUSP 27908:  $9.2 \times 3.6$  mm; MZUSP 27909:  $10.6 \times 4.4$  mm; and MZUSP 27910:  $8.7 \times 3.3$  mm.

*Range:* known from coast of São Paulo State, Brazil.

*Habitat and behaviour:* the host of this species is the crinoid *Tropiometra carinata* (Lamarck, 1816); The gastropods were generally found on the proximal aboral region of the crinoid arms, but some young specimens were collected on mid region of the arms, and only one on the cirri. At Enseada Beach, about 25% of the crinoid specimens were parasitized, some individuals having up to 5 snails. The small snout is used to attach the snail to the host, the snail stays within a viscous, transparent mucus, but it leaves its host immediately when disturbed. Except for minor scarring, no apparent injury to parasitized crinoids was observed. The scars produced by the snail are found near arm joints of the host (Fig. 25), and have 3 regions: (1) the outer region (diameter about 1 mm), where only the surface of host wall is eroded; (2) an intermediate region (diameter about 0.5 mm), with decalcification and only soft tissues preserved; and (3) the inner region, where there is perforation into the host tissues.

There is a little variation in the colour of the snails especially when compared to the large colour variation of their host, but camouflage is provided by the pattern of the gastropod mantle, which blends with the pinnules of crinoid arms.

The snails are very active and move quickly. *A. aurisflamma* was found from the intertidal zone to 8 m depth.

*Etymology:* the specific name refers to the irregular yellow (Latin. *auris*) banding of the mantle, like a flame (Latin *flamma*).

## DISCUSSION

*Annulobalcis aurisflamma* has the tegument elevation around the eye, observed by Warén (1981) in *A. marshalli*, but it differs from this New Zealand species by its small snout, mantle

colour and by its host. *A. aurisflamma* differs from the Japanese species *A. yamamotoi* Habe, 1974 and *A. shimazui* Habe, 1965 in lacking spiral sculpture of the shell, by mantle colour, host and habitat. The shell characters of all *Annulobalcis* species are very similar.

*Annulobalcis aurisflamma* has conchological similarities to the West American deep-water species *Eulima ptilocrinicola* Bartch, 1907, which differs in mantle colouration, and in having a different host and habitat. The shell character and crinoid parasitism show that *E. ptilocrinicola* belongs to *Annulobalcis*.

Within the Eulimidae *sensu* Warén (1983), *A. aurisflamma* occupies an intermediate state of morphological modification to parasitism. It has an almost complete digestive system, but radula, salivary glands and stomach are absent. The following characters appear to be exclusive to *A. aurisflamma*: (1) the host; (2) the mantle colouration; (3) the inner projection of the proboscis near the mouth; and (4) female phase with persistent penis.

#### ACKNOWLEDGEMENTS

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#### ABBREVIATIONS

ag = albumen gland	os = osphradium
an = anus	ov = ovary
bp = buccal projection	pa = perforation area
cg = capsule gland	pb = proboscis
da = decalcified area	pc = pericardium
dg = digestive gland	pe = penis
du = duct of pedal gland	pi = pinnule
ea = eroded area	pr = propodium
ey = eye	ps = pallial sulcus
ex = external face of the penis	pt = prostate gland
gi = gill	rc = rectum
hg = hypobranchial gland	rd = distal region of the penis
in = inner face of the penis	rp = proximal region of the penis

SIMONE & MARTINS: A NEW SPECIES OF EULIMIDAE FROM BRAZIL

it	= intestine	rt	= retina
ki	= kidney	sd	= seminal duct
le	= lens	sm	= proboscis opening
me	= mesopodium	sn	= snout
mf	= muscle fibres	sr	= seminal receptacle
mp	= metapodium	su	= sperm gutter
mt	= mantle border	te	= tentacle
oe	= oesophagus	tg	= tegument
op	= operculum		





# A FRESHWATER PROSOBRANCH, *MELANOIDES TUBERCULATA*, IN A HYDROGEN SULPHIDE STREAM

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(Accepted for publication, 20th November, 1994)

**Abstract:** Hydrogen sulphide is poisonous to aerobic organisms and consequently molluscs are rarely found in streams with high concentrations of H<sub>2</sub>S. In the Arava Desert (Israel) we found a freshwater snail, *Melanoides tuberculata*, in a stream with a sulphide gradient. The H<sub>2</sub>S gradient ranged from 7.3 to 0.1 mg/litre, and adult (but not juvenile) *M. tuberculata* were found to survive in oxygen-depleted water containing hydrogen sulphide concentrations of 3.4 mg/l. In these micro-habitats *M. tuberculata* may perhaps breath aerobic oxygen. Juveniles were found further down the gradient and their frequency in the population gradually increased, from 0% at 3.4 mg/l to 10% at 1.8 mg/l, and to 56–61% at <0.1 mg/l. These data suggest either that snails invading the high-sulphide micro-sites do not reproduce, or that they reproduce but the juveniles are unable to survive in the sulphide environment.

**Key words:** Hydrogen sulphide, *Melanoides tuberculata*, freshwater gastropods, environmental factors, juvenile survival, Israel.

Hydrogen sulphide, H<sub>2</sub>S, is poisonous to aerobic organisms, as it inactivates the cytochrome oxidase enzyme (Cole 1979). Consequently, molluscs are very rarely found in streams with a high concentration of H<sub>2</sub>S. Here we report the occurrence of *Melanoides tuberculata*, a freshwater prosobranch, in a stream with a sulphide gradient.

En Dohan (I.G. 16810–01315, altitude – 15 m, 7 km south of Hazeva) is a small artesian well in the Arava Desert, Israel, drilled to a depth of 692 m in 1972. The lukewarm water (28° C) is very rich in H<sub>2</sub>S and has a strong characteristic odour.

The site was abandoned in 1977, but water continued to gush forth, spreading freely over the immediate vicinity, forming small puddles which soaked into the soil or evaporated. In 1989–90 the place was converted into a watering site for wild animals. A small pool was constructed around the well, from which a 45 m long (0.5 wide, 10 cm deep) canal was dug, leading into a newly formed pond (Fig. 1). To prevent mosquito outbreaks, the pond (27° C) was stocked with fish (*Tilapia*).

Within a few months, lush vegetation developed. Today, the dominant plant surrounding the pool and upper few metres of the canal is the sharp-pointed rush (*Juncus acutus* L.) which further down the canal is gradually replaced by common reed (*Phragmites australis* Cav. Trin.). In the pond these reeds thrive to such an extent that they are periodically removed to prevent them covering its entire surface.

Wildlife (gazelle, honey badgers, birds) have been watering at the site almost since its construction, as have the camels of nearby Bedouin families. Any of these animals could have brought snails from neighbouring natural springs, in mud stuck to hooves or legs, thereby introducing them to the site. When we visited En Dohan on 16 March 1994 (and later again on 26 April 1994), we found thriving populations of *Melanoides tuberculata*, that were present also at micro-sites that seemed to contain high sulphide concentrations. To

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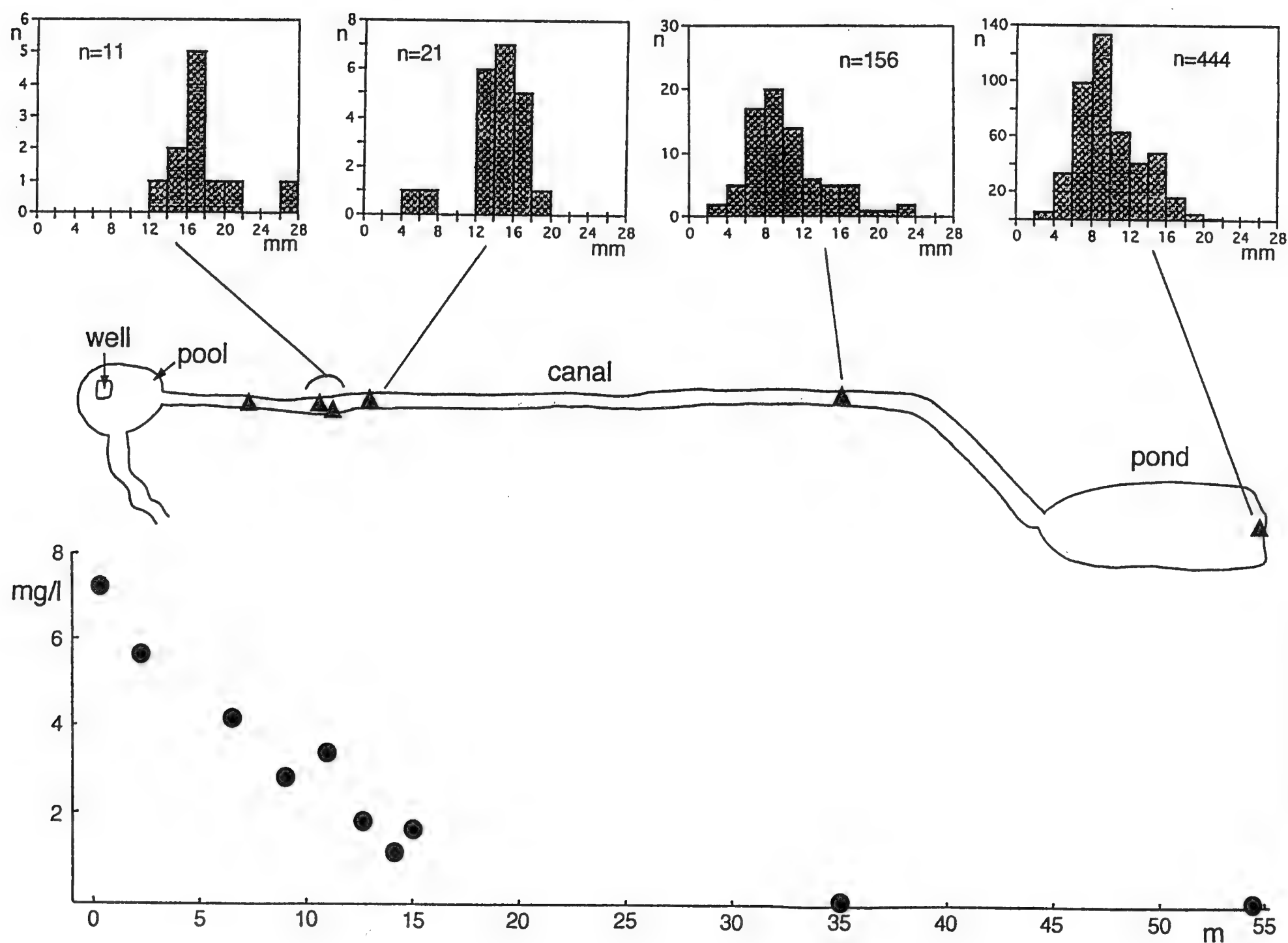


Fig. 1. En Dohan: Map (middle), hydrogen sulphide concentrations (below), and *M. tuberculata* population structures (above) along the site

examine snail abundance in this sulphide-rich site quantitatively, the water was analysed and snails were enumerated at several points between the well and the pond.

Hydrogen sulphide concentrations in these samples were determined by iodometry (Greenberg *et al.* 1992). The results (Table 1, Fig. 1) reveal a gradient of sulphide concentrations, ranging from a high 7.3 mg/l within the well, decreasing via 1.6 mg/l 15 m downstream, to no more than 0.1 mg/l at a point 35 m from the well. Interpolation from our data suggest that within twenty metres, the initially high concentrations of hydrogen sulphide decrease to negligible traces.

TABLE 1

En Dohan: water chemistry (mg/litre) at ten micro-sites

	Gases		pH	electrolytes		Na	K	SO <sub>4</sub>	HCO <sub>3</sub>	Cl
	H <sub>2</sub> S	O <sub>2</sub>		Ca	Mg					
well	7.3	0	7.3	219	171	350	32	621	312	858
pool	5.7	0	7.4	195	116	271	20	627	334	442
6.5 m	4.2	0	7.6	191	98	272	20	570	320	454
9 m	2.8	0	7.6	199	118	271	20	694	332	452
11 m	3.4	0	7.4	185	98	272	20	570	325	455
12.5 m	1.8	0.5	7.4	188	98	273	21	570	312	454
14 m	1.1	—	7.7	165	119	270	20	706	332	448
15 m	1.6	—	7.6	178	118	277	20	700	325	446
35 m	<0.1	4	7.9	187	100	279	21	580	317	462
pond	<0.1	2	7.9	194	119	278	21	740	332	450



Anaerobically-produced sulphide is short-lived in oxic environments. The limits of the zone where sulphide and oxygen co-occur fluctuate in response to physical and biological processes (Cavanough 1994). Oxygen solubility in water exposed to water-saturated air is 8.4 mg/l at 25° C, and 7.6 mg/l at 30° C (Greenberg *et al.* 1992). At En Dohan dissolved oxygen was measured by iodometry (Greenberg *et al.* 1992). We found no oxygen whatsoever within the well, or at points 6.5 and 10.5 m downstream; an oxygen concentration of 0.5 mg/l was found at 12.5 m, increasing to 4 mg/l 35 m downstream and then dropping to 2 mg/l within the pond (perhaps due to consumption by the dense fish population). Thus, hydrogen sulphide and oxygen were found to co-occur only at one point along the canal, 12.5 m.

Electrolyte concentrations were analysed at seven points by applying standard methods (Greenberg *et al.* 1992). Our results (Table 1) indicate a gradient of increasing pH from well to pond; no gradients were found concerning the electrolytes. With chloride concentrations of 440–860 mg/l, En Dohan is within the range of salinity values known for *M. tuberculata* at other sites, both in Israel (20–2500 mg/l, Heller & Farstey 1990) and elsewhere (e.g. up to 3900 mg/l in Tunisia, Meier-Brook *et al.* 1987).

To examine snail abundance along this sulphide-rich (and oxygen-poor) gradient, we enumerated all snails at several points along the canal, each comprised of a 0.5 m stretch. No snails were observed in the well, in the surrounding pool or in the first few metres along the canal. A single snail was found 7 m downstream from the well, six were found 10.5 m downstream from it, and five at 11 m (where sulphide concentrations were 3.4 mg/l). The shells of many of these individuals were covered by a whitish sediment of sulphur, typical of the substratum in these sulphide-rich parts of the canal, indicating that they had been dwelling at this stretch of the canal for quite some time. At 12.5 m downstream (1.8 mg/l H<sub>2</sub>S) twenty-one uncoated snails were found. At 35 m (0.1 mg/l H<sub>2</sub>S) seventy-eight non-covered individuals were found within a small stretch of only 0.25 m; extrapolating this piece of evidence from the previous points, this should account for 156 individuals. At all points along the canal the snails were found mostly near the banks rather than in the strong current at the middle. The pond (0.1 mg/l H<sub>2</sub>S) contained the highest densities of *M. tuberculata*; 444 individuals per 0.50 × 0.25 m. To summarize, some individuals of *M. tuberculata* can survive in hydrogen sulphide concentrations of up to 3.4 mg/l. Population densities in these sulphide-rich micro-sites are, however, very meagre, as compared to populations in sulphide-lacking micro-sites just a few metres further downstream. *M. tuberculata* can even survive in water that totally lacks oxygen. In these micro-habitats, which are so shallow that the snails are barely covered, *M. tuberculata* perhaps breathes aerobic oxygen.

To investigate population structure along the sulphide gradient, we measured all snails in our samples, to an accuracy of 0.01 mm. There were no juveniles (snails of less than 10 mm) in the high sulphide concentrations (3.4 mg/l H<sub>2</sub>S); they comprised 10% of the population at 12.5 m (1.8 mg/l H<sub>2</sub>S); 56% of the population at 35 m (0.1 mg/l H<sub>2</sub>S) and 61% in the pond (0.1 mg/l H<sub>2</sub>S). These data suggest either that snails invading the high-sulphide micro-sites do not reproduce, or that they reproduce but the juveniles do not survive in the sulphide environment. Apparently, adults wander upstream to form some sort of allochthonous 'population' where they can tolerate the higher H<sub>2</sub>S concentrations; perhaps they find these upstream sites attractive on nutritional grounds.

*M. tuberculata* ranges from far-eastern Asia into Africa, and throughout much of its distribution it reproduces parthenogenetically. In Israel, however, viable males have been found, at a frequency varying from zero to 66%. Strongly different male frequencies have been found at two natural springs not far from En Dohan. At En Tamid (11 km to the north) the population contained 36% males, and at En Amazya (20 km northeast) there were only 2% (Heller & Farstey 1990). To examine male frequency at En Dohan, 90 individuals were collected from the pond and inspected in the laboratory by holding them up to a strong light (see methods in Heller & Farstey 1989). No males were found.

In addition to *M. tuberculata*, the only aquatic macro-invertebrates inhabiting the sulphide-rich sections of En Dohan were syrphid larvae of the genus *Eristalis*. They were numerous mainly in the pool surrounding the well and the first 15 m of the canal, including sulphide-rich sites in which no snails were found. *Eristalis* larvae possess an elongated caudal respiratory tube and thrive in water that is shallow enough to project the tip of the respiratory tube above the surface (Pennak 1978). Therefore, at En Dohan they do not breathe the aqueous sulphide to which *M. tuberculata* is exposed. As they feed on decaying matter, syrphid larvae may perhaps compete with snails for food.

Many individuals of the planorbid *Helisoma duryi* were found, but only in the sulphide-deficient pond, where *M. tuberculata* were plentiful too. Of American origin, *H. duryi* is widely introduced throughout Israel and it has been recorded in the Sappir Reservoir, 7 km south of En Dohan.

We have been unable to find any literature on snails in freshwater sulphide gradients. In the marine habitat, however, more than 100 species of gastropods have been described from near thermal vents (Warén & Bouchet 1993) where the hydrogen sulphide concentrations may reach thirty times that of En Dohan (see Edmond *et al.* 1982). In thermal vents, resistance to poisoning by sulphide is due not to the presence of sulphide-insensitive respiratory systems, but to a variety of protein systems which either prevent the entry of sulphide into the animal cells, or oxidize the sulphide that does penetrate (Felbeck *et al.* 1983). No such mechanisms have been described for freshwater snails. Some thermal vent molluscs take advantage of endosymbiotic bacteria that base their metabolism on oxidation of hydrogen sulphide. The molluscs gather it from the water and transfer it to the bacteria in their gills, that in turn use it as their energy source for synthesis of organic compounds, which are then used by the mollusc. No such symbiosis has been described for freshwater snails.

To conclude, we found that adult (but not juvenile) *M. tuberculata* survive in oxygen-depleted water containing hydrogen-sulphide concentrations of 3.4 mg/l.

#### ACKNOWLEDGEMENTS

We are indebted to A. Shapira (Hazeva Field School) for introducing us to the site of En Dohan and for his warm hospitality. O. Ben Yehuda (Hebrew University) kindly examined the sex ratios of *Melanoides tuberculata*. M. Abadi (ex-warden of the Nature Reserves Authority) offered much useful information, as did A. Bar'am of the Mekorot office in Ashqelon.

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# A NEW SPECIES OF *TRUNCATELLINA* (GASTROPODA: VERTIGINIDAE) FROM MOUNT KENYA AND NEW DISTRIBUTIONAL RECORDS OF *TRUNCATELLINA NINAGONGONIS* (PILSBRY) FROM EAST AFRICA

P. TATTERSFIELD<sup>1</sup>

(Accepted for publication, 20th November, 1994)

**Abstract:** *Truncatellina arboricola* is described as a new species from high altitude forest on the east side of Mount Kenya, Kenya, East Africa. Records of *Truncatellina ninagongonis* (Pilsbry) from western Kenya represent an extension in the known range of this species, being the first from East Africa.

**Key words:** Vertiginidae, *Truncatellina*, Kenya, Africa

## INTRODUCTION

The genus *Truncatellina* Lowe, 1852 is known from Europe, the Atlantic Islands, parts of Asia, Japan and Africa (Pilsbry 1920–1921). It is distributed widely throughout sub-Saharan Africa (Adam 1954, 1957, van Bruggen 1994, De Winter 1990) and Verdcourt (1983) lists four species from East Africa (Tanzania, Kenya and Uganda). Snails in the genus are characterised by minute shells which makes them difficult to locate. Additional species have recently been discovered in West Africa (Côte d'Ivoire and Bioko (formerly Fernando Poo)) by sieving leaf litter (De Winter 1990, van Bruggen 1994).

Two species of minute snail were found during visits to Kenya in 1989 and 1991. One of these, a sinistral species found on Mount Kenya could not be identified from the literature or by comparison with museum material: it is described as a new species of *Truncatellina*. The other species, which was found in Kakamega Forest, western Kenya, has been identified as *Truncatellina ninagongonis* (Pilsbry) which has hitherto not been reported from East Africa.

## SYSTEMATIC DESCRIPTION

### Family Vertiginidae

Genus *Truncatellina* R. T. Lowe, 1852

*Truncatellina arboricola* sp. nov.

**Type Locality:** Sirimon Gate, east side of Mount Kenya, Kenya, 37°20'E, 0°0'N. Altitude c.2500 metres above sea level. All specimens collected by P. Tattersfield, 5th August 1991.

From the Montane rain-forest zone of the Montane Forest Belt (*sensu* Hedberg 1951) which is dominated by broad-leaved evergreen trees, including *Podocarpus* sp. and *Juniperus*

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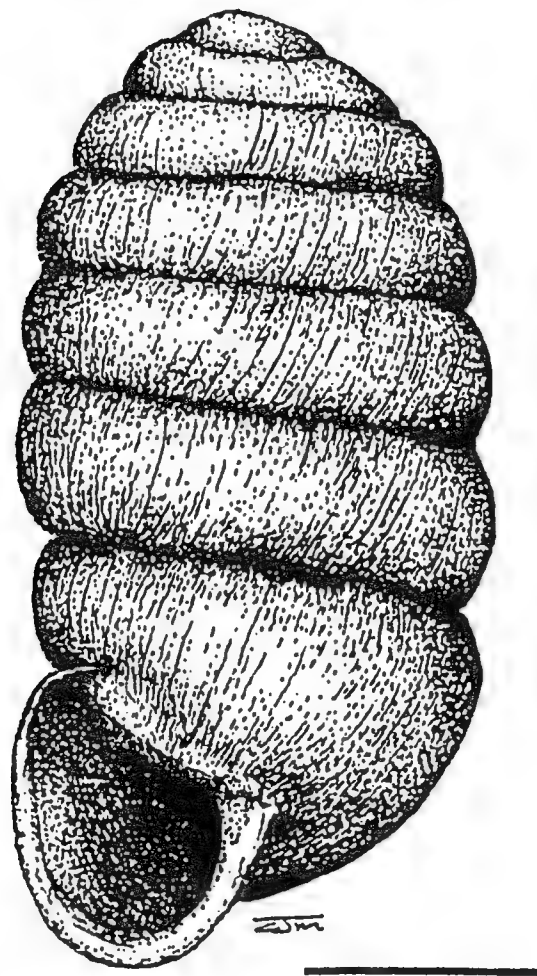


Fig. 1. Shell of holotype of *Truncatellina arboricola*. Scale bar = 0.5 mm.

*procera* Hochst. ex Endl. Five specimens were found amongst moss and accumulated detritus, about 1.5 metres from the ground, on a single living tree trunk. No additional *Truncatellina* were found on other tree trunks or in other microhabitats in the vicinity despite an intensive search for at least 90 minutes.

*Type Material:* The holotype (NMW.Z.1993.054.01) and paratype 1 (NMW.Z.1993.054.02) have been deposited in the National Museum of Wales, Cardiff, UK. Paratypes 2 and 3 (No. 56816) in National Museum of Natural History, Leiden, Netherlands and paratype 4 (No. 1994052) in Natural History Museum, London.

*Description:* Shell (Fig. 1) minute (dimensions are given in Table 1), sinistral, pale yellowish brown, translucent, surface not glossy but rather shiny with poorly defined, very fine and rather regular lines. A series of more pronounced, crease-like folds is present immediately behind the outer peristome edge on some shells.

The basal three quarters to four fifths of the shell is sub-cylindrical, the remainder consisting of a domed, blunt apex. Whorls 7.5 to 8.5, moderately convex. The 5th and 6th whorls are slightly wider than the others, resulting in a bulge in the middle to upper half of the shell, this being the widest point of the shell. The last whorl occupies about two fifths of the total shell height. Minutely and deeply umbilicate. Shell mouth without teeth, slightly taller than wide (Table 1). Peristome thin, without thickening or with only barely perceptible thickening on some shells, slightly reflected, especially on its basal and columellar margins.

TABLE 1

Dimensions<sup>1</sup> (in mm) of *Truncatellina arboricola* sp. nov.

	Shell		Aperture		Last whorl Height
	Height	Width (Max)	Height	Width	
Holotype	2.04	1.00	0.63	0.54	0.87
Paratype 1	1.96	0.96	0.61	0.52	0.78
Paratype 2	2.09	0.97	0.61	0.53	0.83
Paratype 3	2.23	0.97	0.62	0.52	0.84
Paratype 4	2.00	1.00	0.61	0.53	0.83

<sup>1</sup> Measurements follow the scheme presented in Fig. 1 of Adam (1954).



*Comparisons and discussion:* This species has been placed in *Truncatellina* because of its minute size and its relatively tall and sub-cylindrical shell shape. The sinistral shell geometry of *T. arboricola* differentiates it from all other known members of the genus except *T. pygmaeorum* (Pilsbry & Cokerell, 1933), which was originally placed in *Columella* but later assigned to *Truncatellina* by Adam (1954). *Truncatellina pygmaeorum* was described from Zaïre (Belgian Congo) but it is apparently quite widespread in montane forest habitats in sub-Saharan Africa having also been recorded from the Aberdares, Kenya (Verdcourt 1970). from Malaŵi where it is widespread and Angola (van Bruggen 1994). The distinctly tapering spire of *T. pygmaeorum* (paratype in BMNH and illustrations in Pilsbry & Cockerell (1933), Adam (1954), Verdcourt (1970) and van Bruggen (1994)) serve to separate it from *T. arboricola*. Shells of *T. p. pygmaeorum* are also larger than *T. arboricola* although the smaller subspecies, *T. p. katangae* which was distinguished by Adam (1954), falls into the size range of *arboricola*. However, van Bruggen (1994) has shown that the size variation in *T. pygmaeorum* may be clinal, with smaller shells generally occurring in the south of the species' range and that there is therefore no reason to retain a separate name for smaller individuals.

Examples of abnormal shell sinistrality have been reported in several genera in the Vertiginidae (for example, in *Nesopupa* (van Bruggen & Verdcourt 1993) and *Vertigo* (Standen 1905)), but, as far as is known, not in the genus *Truncatellina*. Normal sinistral chirality occurs in several vertiginid genera. In order to eliminate the possibility that the new species is a sinistral population of a normally dextral species, other *Truncatellina* species described from equatorial Africa have been reviewed. Apart from the different chirality, the other species reported from Central, West and East Africa show the following differences from *arboricola*. The closest species appears to be *T. ruwenzoriensis* Adam, although its shell tapers more gradually at the apex and it has more pronounced costulation. *Truncatellina naivashaensis* (Preston) (including var. *elgonensis* (Preston) and *T. mutandaensis* (Preston) which van Bruggen (1994) has shown to be synonymous with *naivashaensis*) has distinct costulae, a narrower shell and smaller aperture height. *T. upembae* Adam is smaller and has fairly coarse, widely spaced costulae. *T. adami* van Bruggen has a larger shell and is from the geographically isolated island of Bioko, whereas the shell of *T. obesa* shell is more conical. The Kakamega specimens of *T. ninagongonis* (Pilsbry) (see below) have shorter and narrower shells, and smaller aperture height. *T. flavogilva* Germain is described as having striation on the initial whorls and costulae on the latter ones (Adam 1954); however, further diagnostic information about this species is needed (see Adam 1954 and van Bruggen 1994).

#### ***TRUNCATELLINA NINAGONGONIS* (PILSBRY, 1935) FROM WESTERN KENYA**

In July 1989, a small number of a *Truncatellina* were collected from Kakamega Forest, western Kenya (0°15'N; 34°54'E) which were tentatively identified by Dr B. Verdcourt as a new species (Verdcourt 1990). Further material was obtained from several stations (altitude range: 1500–1600m asl) during an intensive mollusc survey of the forest in 1993 (Tattersfield, in prep.). A review of the literature on African *Truncatellina* indicated that the Kakamega species resembled *T. ninagongonis* (Pilsbry) and critical examination of the holotype, loaned from the Museum of Comparative Zoology, Cambridge, Mass. USA (MCZ 77286) (J. Bequaert Collection) confirmed this identification, although it was noted that some of the Kakamega shells were shorter and with rather less tumid whorls than the type. The dimensions of the Kakamega shells are given in Table 2.

*Truncatellina ninagongonis* has previously not been recorded in East Africa (Verdcourt 1983). It was originally described (Pilsbry 1935) from Mount Ninagongo, eastern Zaïre (c. 2700 m asl) but van Bruggen (1994) reports that it occurs at further sites in eastern Zaïre

TABLE 2

Dimensions<sup>1</sup> (in mm) of *Truncatellina ninagongonis* (Pilsbry) collected from Kakamega Forest, Kenya

Reference	Shell		Aperture		Last whorl Height
	Height	Width (Max)	Height	Width	
1	2.30	0.94	0.61	0.61	1.00
2	2.04	0.96		Broken	
3	1.85	0.82	0.54	0.50	0.83
4	1.83	0.78	0.52	0.48	0.83
5	1.78	0.85	0.52	0.48	0.78
6	1.78	0.78	0.50	0.48	0.77
7	1.74	0.77	0.52	0.44	0.75
8	1.72	0.78	0.52	0.50	0.78
9	1.70	0.77	0.49	0.49	0.66
10	1.70	0.78	0.48	0.44	0.78
11	1.70	0.80	0.48	0.48	0.78
12	1.65	0.78	0.52	0.52	0.78
13	1.57	0.76		Sub-adult	
14	1.57	0.77	0.44	0.44	0.77

<sup>1</sup> Measurements follow the scheme presented in Fig. 1 of Adam (1954).

between c. 1000 c. 2700 m asl. and also in Malaŵi (from c. 550 and c. 2200 m asl.) and Zambia (c. 2180 m asl.). As commented by van Bruggen (1994), it seems likely that this species will be found in other suitable habitats in Central, East and perhaps also Southern Africa. Kakamega Forest is acknowledged to be the most easterly area of Congo-type rain forest in Africa (Hedberg & Hedberg 1968) and its fauna and flora supports many Central and West African species. In a biogeographical context, the presence of a species originally described from Central Africa is not unexpected.

## ACKNOWLEDGEMENTS

I am grateful to the Drs P. G. Oliver and M. B. Seddon of the Department of Zoology, National Museum of Wales for advice and support and to Dr. B. Verdcourt, Kew, for advice and comments on a draft of this paper. Mr. Chris Meechan of the National Museum of Wales kindly provided the drawing. I am also grateful to Dr. A. C. van Bruggen, Leiden, who kindly compared *T. ninagongonis* from Kakamega with material collected from southern Africa. Part of the work in Kakamega Forest was supported by the British Ecological Society, People's Trust for Endangered Species and the Percy Sladen Fund of the Linnean Society. The National Museums of Kenya, especially Musombi Kibberenge, also provided support for part of the Kakamega Forest Survey.

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## ADDENDUM

Following acceptance of this paper, Dr A. C. van Bruggen (Leiden) published revisionary notes on the African genus *Negulus* O. Boettger (van Bruggen 1994). The paper includes a reassessment of *N. abyssinicus* (Von Martens, 1869) which, like all other known species of the genus, normally has a dextral shell. However, van Bruggen's also includes an appraisal of an abnormal sinistral specimen of *abyssinicus* collected in south Sudan by the German ornithologist and explorer Theodor von Heuglin. Although van Bruggen expresses the view that Von Heuglin's sinistral specimen 'undoubtedly represents a sinistral individual of *N. abyssinicus*' he also notes several ways in which it differs from the dextral material. Accordingly, he decided to take a cautious line and excluded it from the series of paralectotypes. Van Bruggen noted that the sinistral shell had more whorls for a given shell length and that the length of the last whorl was slightly shorter than in the typical dextral specimens.

On examining van Bruggen's (1994) illustration of the shell of the sinistral *N. abyssinicus* I was immediately struck by its close similarity to *Truncatellina arboricola*. Dr van Bruggen subsequently kindly compared paratypes 2 and 3 of *arboricola* with the sinistral *abyssinicus* and advised that they are very close indeed. The shell of the sinistral *abyssinicus* has the following dimensions (mm): 1.9 (height) × 1.0 (major diameter), 0.9 (height of last whorl), 0.7 × 0.6 (aperture height × major diameter); it has 6.5 whorls. It is therefore slightly shorter than *arboricola* and consequently has fewer whorls. The aperture of *arboricola* is also slightly less rounded and smaller. There would appear to be two possibilities to account for this situation. Either Von Heuglin's sinistral shell and the Mount Kenya *Truncatellina* are the same species but they differ slightly because they come from different locations or they are two separate species. Normal shell sinistrality is known to occur in the genus *Truncatellina* but the *abyssinicus* specimen is the first reported example in *Negulus* (although undoubtedly far less material of *Negulus* been examined): this might favour the first option. It is clear that more material from other locations, and ideally anatomical data, would be needed to resolve this problem.

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# THE SLIPPER LIMPET, *CREPIDULA FORNICATA* (L.), IN IRISH WATERS, WITH A REVIEW OF ITS OCCURRENCE IN THE NORTH-EASTERN ATLANTIC

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(Accepted for publication, November 20th, 1994)

**Abstract:** There are seven localities where the slipper limpet, *Crepidula fornicata*, has been recorded in Irish waters. Most introductions to Ireland were with transfers of oysters from America, Britain and mainland Europe. These records are discussed in relation to the expansion of the slipper limpet's European range. Populations may have become established in Kenmare and Clew Bays, but following the prolonged cold period in 1963 no living populations have survived. In 1993, following an European Community directive on free trade, the Pacific oyster, *Crassostrea gigas*, was imported from France and was found to carry *C. fornicata*.

**Key words:** *Crepidula*, Geographical range, Introduction, oysters, Ireland.

## INTRODUCTION

*Crepidula fornicata* (L.) is one of a number of slipper limpets native to the east coast of North America, where it ranges from the St. Lawrence River to Texas (Fretter & Graham 1981). An isolated population exists in Uruguay (Parodiz 1939). Its range has been extended by accidental introduction to the American North Pacific coast and Japan (Habe & Maze 1970) and also to the Mediterranean, where it is known from Sicily and the Adriatic (Parenzan 1939) and is widespread in Northern Europe.

In this account the occurrence of *C. fornicata* in Irish waters is discussed. It is generally assumed that it was only introduced once to Ireland, this was to Kenmare Bay (Arnold 1960). Living specimens or shells from seven Irish localities are discussed here (Fig. 1). The areas from whence they were introduced were dependent on the expansion of the range of this species throughout Europe. With the development of free trade within the European Community from January 1993, Pacific oysters were transferred from France to Ireland and with them small numbers of *C. fornicata*.

Turton (1865) recorded the first slipper limpet introduced to Europe as *Crepidula sinuosa*. A single specimen was collected from the hull of a ship that had recently arrived in Scarborough from North America. Jeffreys (1865) considered it to be *Crepidula plana* Say, known from the Pacific coast of North America. This species never became established in Europe.

The first known occurrence of *C. fornicata* in Europe was from Liverpool Bay, England, in 1872. These specimens were introduced with the American hard shelled clam, *Mercenaria mercenaria* L. (McMillan 1938). During the late 1870's the American oyster *Crassostrea virginica* Thunburg, was trans-shipped from Long Island Sound, U.S.A. to England and Ireland in barrels. In the early years of this trade, oysters with attached *C. fornicata*, were laid

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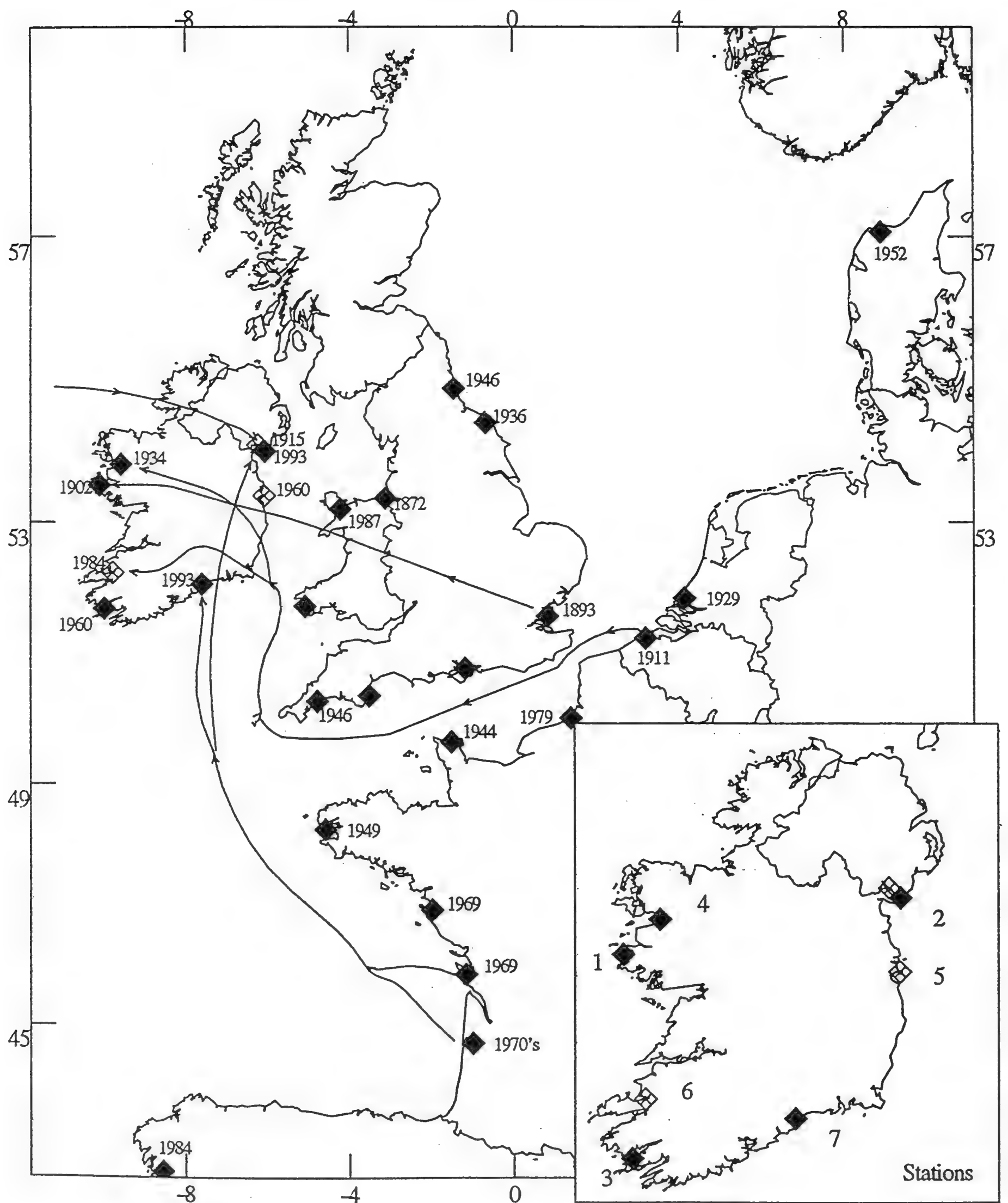


Fig. 1. Distribution of *Crepidula fornicata* in Northern Europe and (inset) the Irish localities where live (solid diamonds) and shell (open diamonds) specimens have been located. Likely source areas of Irish specimens are indicated by arrows.

near Liverpool, where the limpets have since died out, and at Brightlingsea in Essex (Cole 1952). The occurrence of slipper limpets on the SE coast of England was not noticed until 1893 (Crouch 1895), when some were found at Creeksea, associated with oysters which had been relaid there from nearby Brightlingsea. In Britain, *C. fornicata* appears to have been confined to the SE coast, where it became locally abundant, until the 1940's.

Slipper limpets extended their range to Weymouth Bay sometime after 1939, where they attained dense concentrations of up to  $1750\text{m}^{-2}$  (Seaward 1987). In the Solent they were considered to be the most dominant members of the macrofauna in 1971. Here shells of *C.*



*forficata* were used as a substratum by settling native oysters, *Ostrea edulis* L. (Barnes *et al.* 1973). Cole (1952) reports the presence of one or two shells of *C. forficata* in the Helford River, SW England, during the 1930's. These records were discounted at the time as it was assumed these shells had been misidentified. In 1946 a shell (29mm length) was confirmed from the Helford River. In the following year, a specimen was found in the Fal, possibly introduced by naval shipping from the established population at Portsmouth (Cole 1952). By 1949, forty-seven specimens had been found in the Helford River, including three chains of individuals. For a few years a bounty was paid by the British Ministry of Fisheries for each shell collected and in 1953 almost 2,000 were gathered (Cole & Hancock 1956).

Elsewhere in England the range of *C. forficata* expanded. Two were found seven miles ENE of the Tyne Estuary in 1936. A further specimen found in this area was thought to have fallen from a ship in transit (Bull 1939). In 1946, they were found in Blyth, Northumberland, on the hull of a German warship being scrapped (1952). In the years that followed, individuals were found on mussels on the nearby shore (Cole 1952). The species also extended its range westward to Start Point, Devon (Orton & Rogers 1950) and the Bristol Channel (Seaward 1982). This last range extension may also have been associated with oyster transfers. More recently during the 1980's shells were found near Bardsey Island in North Wales (I. Rees, pers. comm.).

The most recent summary of the distribution of *C. forficata* in Britain is that of Seaward (1990), which shows the majority of British records are on the south-west, south and south-east coasts.

*C. forficata* was first recorded from mainland Europe at Ostende in 1911 (Fretter & Graham 1981). Korringa (1951) found about a dozen slipper limpets attached to wreckage on the Dutch coast in October 1926. These may have drifted from the English coast. Korringa later reported specimens from the Oosterschelde in 1929, introduced with oysters. In the following year hundreds were found, and by 1933 they were abundant.

The first records of *C. forficata* in France were from Calvados in 1949 (Cole 1952), possibly transported there during the Normandy invasion of the second World War in 1944. These were probably carried on the bottom of ships or on temporary harbour installations (Mulberry harbours), previously moored in estuaries on the south and south-east coasts of England. *C. forficata* had become established in Hermanville, France by 1949, when Cole (1952) collected individuals and 'chains' attached to mussels. In the same year it was found in the Rade de Brest on the scallop, *Pecten maximus* (L.) (Cole 1952). Here it rapidly colonized substrata usually occupied by bivalves (Coum 1979) and in 1978 shells completely carpeted the seabed in some areas (pers. ob.). In 1952 it was not found associated with oysters in French waters but by 1979 had become a serious competitor of the native oyster (Dupouy & Latrouite 1979). In the same year it was found on scallops in the Baie de Seine (Kergariou *et al.* 1979). *C. forficata* had extended south to La Loire near Point St Gildas (Marteil 1965) and had reached Marennes-Oleron by 1969–70. The population here had attained an estimated 700 metric tonnes by 1982, resulting in reduced oyster landings due to trophic competition (Piquion 1985). The rapid extension of the geographical range within France was almost certainly assisted by oyster transfers, a common practice. Transfers of *C. forficata* to Vigo, Spain, may also have been with oysters (Mosquera 1984). Slipper limpets established in the Oosterschelde, may have been transferred to the German Waddensea and the Limfjord, Denmark, in the same way (Korringa 1951).

#### RECORDS FROM IRELAND

Despite the rapid range extension of the slipper limpet throughout Europe, Ireland does not have a population. Nevertheless there are records from seven localities where this species has

been found either alive or as shells (Fig. 1.). Some of these sites have been examined by shore and diving surveys since 1980. The records in order of date are:

**1. Ballinakill Bay, Co. Galway** (53° 33'N, 10° 03'W).

Live individuals were found in barrels of American oysters imported from Essex, England, for growth trials. Sykes (1905) removed these limpets and commented that, should the species be found in Ballinakill Bay in future years, this introduction was the probable source. He believed that some small individuals could have been overlooked. Surveys of this bay were later carried out by Colgan (1909–11), and by C.B.D. & D.M. in 1987 but no specimens were found on either occasion.

**2. Carlingford Lough, Co Louth** (54° 02'N, 06° 10'W)

Six worn shells, 18–38mm length, collected in this lough, were presented by the Rev. A. B. de Montmorency to the National Museum of Ireland (NMI 130.1915). These were labelled . . . 'from American oysters' . . . This area has been re-visited since the 1960's by C.B.D., neither he, nor the oyster farmers, have found further shells.

In 1993 importations of half-grown Pacific oysters, *Crassostrea gigas* (Thunberg), to Ireland took place following changes in EC legislation on trade, and, although these oysters had been screened, *C. fornicata* was found in consignments (Minchin *et al.* 1993). A single male (6mm shell length) was found attached to imported Pacific oysters held on trestles in February 1993.

**3. Kenmare Bay, Co. Kerry** (51° 43'N, 09° 50'W)

Arnold (1960) reported the occurrence of live, full grown individuals as high as the mid-tidal level on the shore in Kilmakilloge Harbour. Arnold had also searched other areas within Kenmare Bay for slipper limpets but none were found. The same shore was visited during the summer of 1964 and in May and June 1982 by C.B.D. and no live or shell material was found.

**4. Clew Bay, Co. Mayo** (53° 47'N, 09° 52'W)

In 1934, Farran recorded, in files of Department of Fisheries, 2–3% of an imported consignment of Dutch oysters with attached slipper limpets (6–45mm length). Farran removed about 10 litres of slipper limpets before laying the oysters at Inishlyre Roads (an area between partly submerged drumlins) also used as a ship anchorage. In 1961, Mr A. Wallace, hotelier, found a chain of limpets in shallow water on the south side of Inishraher, 4km to the south of Inishlyre Roads. These were said to have been confirmed as being this species by W.J.M. Menzies, (Ministry of Agriculture and Fisheries, Aberdeen, Scotland). We have been unable to trace the specimens. A thorough search of the area in 1963 (by CBD) failed to locate any further specimens, and it was not found during an intensive study in Clew Bay in 1982.

**5. Dublin Bay, Co. Dublin** (53° 20'N, 06° 15'W)

A single shell was found by Mr L. Atkins, of Cork, at the Bull Wall in the 1960's and is retained in his personal collection.

**6. Tralee Bay, Co. Kerry** (52° 17'N, 09° 52'W)

Shells of slipper limpets were dredged from the large natural oyster beds during October 1985. Two, 36mm and 39mm shell length, were taken by Mr K. Flannery of Dingle, at the Wheel Rock near Fenit pier. The largest was an unworn and coloured shell. In the same month the area was visited by D.M. and some tens of empty shells were dredged from the oyster bed, but no live slipper limpets were found. Shells were also found among autoclaved

mussel shell stored on Fenit Pier, imported from Yerseke, the Netherlands. The mussel shell was being used to provide a settlement substratum for oysters within Tralee Bay. Six hundred tonnes of mussel shell had been imported for this purpose in 1984 and 1985 and was clearly the source of the dead slipper limpet shell. A selection of these shells has been deposited in the National Museum of Ireland.

### **7. Dungarvan Bay, Co. Waterford (52° 4'N, 07° 35').**

Two slipper limpets, one of 8mm collected in February 1993 and one of 15mm shell length collected in August 1993, were found attached to half-grown Pacific oysters imported from Marennes-Oleron.

There was a single record from Belfast Lough, Co Antrim, but this is no longer recognized (Smith 1976). No material from Belfast Lough is present in the Ulster Museum and there are no recent reports of its presence.

## **DISCUSSION**

The slipper limpet was introduced to European waters with oysters from the U.S.A. during the last century, and most of the range expansions in Europe and transfers to Ireland would have been from this original source. The species now ranges from Denmark to Spain and into the Mediterranean, where it is abundant in many inlets, as it is on the south-east and southern coasts of England.

The first significant movements of slipper limpets were with oysters packed in barrels exported from North America to Europe. Oysters can survive out of water for many days, but so can slipper limpets, and their establishment in Europe was inevitable once large volumes of oysters were transferred for fattening prior to sale. Landings of the native oyster had by this time declined, due to greater exploitation resulting from an expansion of the railway network, so facilitating rapid access to markets.

At the time of the introduction of oysters from Long Island Sound, shells of *C. fornicata* and *Anomia* species were dredged and relaid to provide suitable surfaces for settlement for *C. virginica* in this area (Rogers 1951). Clearly *C. fornicata* must have been abundant in Long Island Sound at this time.

It is likely that there have been many introductions of *C. fornicata* on American oysters to Ireland. The earliest recorded importation of oysters was November 1875 to Sligo Bay. Thomas Gardiner imported 15,000 at twelve shillings and sixpence (62.5p Irl) per 1,000. Most died during the following summer. Those that survived were in poor condition (Anon. 1876, 1877)

In the 1878 Fisheries Annual Report (Anon. 1879) it is stated that 60,000 American oysters had been removed from a bed in Ballisodare Bay, Co Sligo, having been presumably laid down in 1877. From this time there were annual layings of American oysters at a number of Irish localities into the early part of the next century.

The majority of the American oyster importations were laid in Carlingford Lough. Oysters were also relayed in Cork Harbour, and these may have come directly from New York to Cobh (formerly Queenstown). However, most importations almost certainly came *via* Liverpool, the main British Port for the American trade. They may have been then forwarded directly from Liverpool to Greenore in Carlingford Lough, *via* the then regular shipping service. Greenore had a direct rail connection to the then extensive Irish rail network. The origin of imported oysters, when reported, was given as New York. They were called 'Crown American', 'Bluepoint' or 'East American' oysters. Oysters were packed in



timber barrels each holding 800–1,000 individuals depending on their size. In the 1902 report on the Sea and Inland Fisheries of Ireland, 27,000 'East River' oysters were relaid at Ballisodare, Co Sligo in April 1901. These are described as two inch oysters (*ca* 50mm) costing thirty-five shillings and sixpence (Ir£1.77) per thousand, obtained from Musson & Co., Liverpool. These oysters were probably ongrown over the summer before sale.

The last detailed Annual Report on such oyster introductions (Anon. 1921) recorded that 800,000 American oysters were relaid at Carlingford. The trade was considerably reduced and ultimately ceased in the following years and was not resumed.

Spicer (1923) confirms that introductions to Ireland had taken place and states '... *Crepidula* ... has been taken on the Irish coast on a few occasions, when it was probably introduced with consignments of English and American oysters ...'. Spicer was probably referring, in part, to the observations made by Sykes (1905), the earliest of the known introductions. These oysters came from Essex, where by that time slipper limpets had become well established. In Spicer's account there is no indication as to where in Irish waters the slipper limpets were found, only that they were introduced on American oysters. This report may have been prompted by the finding of slipper limpet shells in Carlingford Lough, lodged in the National Museum in 1919. Farran, as he reported in Departmental files, found large numbers on Dutch oysters imported to Clew Bay and these may have been the origin of the population reported in this area almost twenty years later. However, there were some private introductions of fully grown American oysters, for direct sale, introduced as late as the 1940's which are known to have attached slipper limpets (H. Cleeve, pers. comm.).

McMillan (1968) referred to only a single locality where slipper limpets were found in Ireland, probably Arnold's (1960) record from Kilmakilloge Harbour, Co Kerry. There are no records of oysters being laid in this area, apart from those of the native oyster, over the period 1848–1872 at a time before slipper limpets were likely to have existed in European waters (Wilkins 1989). The finding of specimens close to the mid-tidal level is unusual. According to Fretter & Graham (1981) slipper limpets are usually found sub-littorally and only sometimes found at low water. It is possible that they were originally transferred there on the hull of a small ship or boat, as the Harbour is a known anchorage. Elsewhere *C. fornicata* is known to be transported on ships. Cole (1952) records them from the hull of an oyster dredger in Burnham-on-Crouch, and on the hulls of ships prior to being scrapped.

*C. fornicata* has not established itself in Irish waters despite a number of introductions and the reasons for this are not clear. It would appear that the two live populations, in Kilmakilloge Harbour and Clew Bay, were present before the cold winter of 1962–63, but absent following it, suggesting a vulnerability to cold. Walne (1956) showed that *C. fornicata* was unable to survive exposure to temperatures of  $-6^{\circ}\text{C}$  for 34 hours. A sharp frost during low-water may have caused mortalities, particularly in Kilmakilloge Harbour where individuals near the mid-shore would be directly exposed to frosts. During the cold winter of 1946–47 slipper limpets perished in the upper reaches of the Crouch Estuary, but Cole & Hancock (1956) suggest that these mortalities may have been due to low salinities.

The related Chinese-hat limpet, *Calyptraea chinensis*, has become established in shallow water on the west coast of Ireland (Minchin *et al.* 1987) and may have been introduced on oysters, *O. edulis*, from Brittany during the period 1949–1954. It is unlikely that *C. fornicata* was well established in Brittany at this time and transfers of slipper limpets, should they have taken place, would have been made up of small numbers insufficient to produce a new population.

In Britain the slipper limpet has not developed extensive populations in the Irish Sea or Scottish coasts nor in England north of The Wash (Seaward 1982). Minimum winter temperatures may be important.

Cole & Hancock (1956) noted that in Cornwall the rate of spread of the populations was

slower than anticipated, suggesting that the environmental conditions are not ideal. The same may be true in Ireland. These limiting factors are not fully understood. The Ministry of Agriculture, Fisheries and Food (MAFF) established coastal zones to prevent the spread of shellfish pests, parasites and diseases. Restrictions on shellfish transfer, around the coast of England and Wales, between these zones may have been effective in controlling the spread of slipper limpets. From January 1993, following EC Directive 91/67/EEC, MAFF dropped their restrictions on the movement of oysters from areas where *C. fornicata* in England. In the Republic of Ireland more than 50 tonnes of small and half-grown oysters, *C. gigas*, have been shipped from France to some areas (Carlingford Lough, Dungarvan Bay, Cork Harbour, Oysterhaven and Dunmanus Bay). These oysters carried a number of exotic species including low numbers of small *C. fornicata* (Minchin *et al.* 1993). Therefore sustained introductions of oysters could eventually lead to establishment of populations in Ireland.

It should be noted that occasional records of *C. fornicata* usually precede the expansion of populations some year later; for this reason verbal reports of its occurrence must be treated seriously. Considerable effort expended in the removal of slipper limpets is well justified as soon as these reports are confirmed, as the consequences are serious for inshore fisheries and aquaculture.

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# THREE SOLENOGASTRES FROM THE IRISH SEA, NEW TO THE BRITISH MARINE AREA

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**Abstract:** Descriptions are included of three solenogaster species obtained during benthic faunal surveys of the Irish Sea. All of the species belong to genera unknown from the British Isles, although prior records exist from the Mediterranean. *Tegulaherpia celtica* sp. n. possesses scales rather than spicules and appears to be meiofaunal in silty-sand or shell gravel habitats at depths around 100 m. Scanning electron micrographs show that *Macellomenia* cf. *palifera* is characterized by unusual spicule bases. *Pruvotina* sp. may be conspecific with *P. impexa* Pruvot but presently remains unidentified. In addition some comments are included on other meiofaunal Solenogastres.

**Key words:** Britain, *Macellomenia*, *Pruvotina*, meiofauna, Solenogastres, *Tegulaherpia*

## INTRODUCTION

Eight species of Solenogastres are listed from the British area as defined by admiralty chart number 2 in Smith & Heppell's (1991) checklist of British Marine Mollusca. Marine benthic faunal surveys of the Irish Sea which were undertaken by the National Museum of Wales in 1989 and 1991 (Mackie *et al.* 1995) resulted in the collection of a number of species of Solenogastres from depths between 30 and 170 metres on bottoms of muddy sand, fine sand and coarse shell gravel. Four of these species were additions to those in the checklist; one of them is a new species belonging to the genus *Tegulaherpia*, the second is thought to be conspecific with *Macellomenia palifera* (Pruvot, 1890), previously recorded from the Mediterranean, while the third is a *Pruvotina* species which has not conclusively been identified. A fourth species, *Eleutheromenia sierra* (Pruvot, 1890), was tentatively recorded earlier from the Irish Sea (Hartley 1979), and our samples confirmed its presence there. This species was included by Jones & Baxter (1987) and is not dealt with in detail here. Species lists from the surveys including details of the Solenogastres as well as other fauna will be published separately by other authors.

Some difficulty was experienced in identifying the three species, despite the very characteristic features of the monotypic genus *Macellomenia*. These problems stem from the dispersed nature of the literature and small number of records of some of the European species of Solenogastres. In the light of these problems, a re-description with illustrations has been made of *Macellomenia* cf. *palifera* from the Irish Sea together with descriptions of *Tegulaherpia celtica* sp. n. and the *Pruvotina* sp.

## MATERIALS AND METHODS

The specimens were collected by staff of the National Museum of Wales from R.V. "Prince Madog" of the Menai Marine Laboratory. Samples were taken using a 0.1 m<sup>2</sup> van Veen grab or a 40 cm/0.5 mm inner mesh Tjärno dredge. All of the grab samples were processed on

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board the ship by sieving over a 0.5 mm mesh. Dredge samples were initially picked by eye on deck and the residue elutriated on a sorting table, all material that floated off was retained by 0.5 mm sieve. Samples were fixed with formaldehyde and stained with rose bengal. In the laboratory, specimens were rinsed in water and preserved in 80% industrial methylated spirits.

Specimens were examined and drawn using a Zeiss Stemi SV8 dissecting microscope with interchangeable objectives allowing magnifications up to  $\times 64$ . Glass beads were used to support the animals in a variety of positions for drawing; a squared eyepiece graticule and squared paper was used for transfer of the image to scale. Some specimens and dissected portions of the cuticle were mounted temporarily in glycerol solution for examination of spicules on the compound microscope.

Whole mounted specimens were prepared after removal of the spicules by immersion in a saturated solution of EDTA (ethylenediaminetetra-acetic acid) until decalcification was complete (usually 1 hour or less). Specimens were then stained in Ehrlich's acid haematoxylin, differentiated in acidified 70% alcohol and rinsed in tap water, before dehydration through an alcohol series, clearing in cedar wood oil and mounting in DPX. The mounts were examined on a Reichart Zetopan compound microscope with magnification up to  $\times 1000$ . Measurements were made using a calibrated eyepiece graticule.

The soft parts were removed from specimens or small parts of specimens by placing in a solution of 10% sodium hypochlorite (Scheltema & Kuzirian 1991) in a cavity slide for about 30 minutes, before rinsing in water and transferring to a drop of glycerol. The isolated spicules could then be examined on an inverted microscope.

Further intact specimens were prepared for the scanning electron microscope (SEM) by dehydration through an alcohol series, mounting on aluminium stubs and coating with gold palladium in a sputter coater. The specimens were examined and photographed on the SEM utilizing magnifications from  $\times 40$  to  $\times 5000$ .

## SYSTEMATIC DESCRIPTIONS

### Family *Lepidomeniidae* Pruvot, 1902

### Genus *Tegulaherpia* Salvini-Plawen, 1983

Type species: *Tegulaherpia stimulosa* Salvini-Plawen, 1983.

Type locality:  $43^{\circ} 36' 30''$  N.  $15^{\circ} 50' 30''$  E. 75–80 m. Adriatic Sea.

**Diagnosis:** *Tegulaherpia* is characterized by a thin mantle-cuticle covered with scales, by an atrial sense-organ which is separated from the oral aperture, a distich radula, a ventral sub-epithelial follicular gland of the foregut, unequal secondary sexual apertures, the ability to produce copulatory spicules and a rudimentary dorso-terminal sense organ.

### *Tegulaherpia celtica* sp. nov.

(Fig. 1, a–h, and Pl. 1, a–d)

Species D. Salvini-Plawen, 1988.

**Holotype:** NMW.Z.1994.019.01 (illustrated in Fig. 1, from station 66).

**Paratypes:** NMW.Z.1994.019.02–06

**Type locality:** Station 66, Irish Sea Survey,  $51^{\circ} 57.2'N$ .  $05^{\circ} 55.3'W$ . 95m.

Station data from the 1989 and 1991 Irish Sea surveys:-

Station	Date	Gear	Position	Depth (m)	Substrate	No.
14b	12-7-89	grab	$51^{\circ} 56.9'N$ . $05^{\circ} 55.6'W$ .	110	shell gravel	1

CAUDWELL *ET AL*: THREE SOLENOGASTRES FROM THE IRISH SEA

59	03-8-91	grab	51° 32.0'N. 05° 56.5'W.	109	silty fine sand	1
59b	03-8-91	grab	51° 32.0'N. 05° 56.5'W.	109	silty fine sand	1
62a	03-8-91	grab	51° 16.2'N. 06° 30.1'W.	112	mud with shell & gravel	1
66	05-8-91	grab	51° 57.2'N. 05° 55.3'W.	95	silty sand/gravel/shell	6

*Description:* Specimens minute, size varying from 1.4–2.4 mm in length and 0.29–0.39 mm in maximum depth; holotype measures  $2.4 \times 0.38$  mm. Body elongate, laterally compressed with faint dorsal keel and ventral ridge on each side of the ventral groove (Fig. 1a and d; Pl. 1a). Anterior end broad, slightly tapered in lateral view; oral and cloacal apertures ventral. Body may assume a number of forms in preserved specimens, typically with dorsal and ventral margins almost parallel, before tapering posteriorly towards the narrowest point at the posterior end, close to the mantle cavity opening. Some specimens tended to take on a 'whale-like' or 'fish-like' shape, caused by undulations in the dorsal line of the body and concave ventral margin (Fig. 1c; Pl. 1a). The body is not normally coiled in preserved specimens. General appearance is silvery and smooth as light is reflected on the small scales which cover the body. The narrow ventral groove measuring about 80–120  $\mu\text{m}$  in diameter runs mid-ventrally from the indistinct pedal pit to the opening of the mantle cavity (Fig. 1a–b). The body is covered with small, closely adpressed, scale-like spicules which overlap in the manner of roof-tiles (Fig. 1f (left), h, Pl. 1b); these vary slightly in shape along the body. Anteriorly, in the post-oral area, the projecting ends of these scales are broad, rounded and smaller, while mid-laterally and posteriorly they are larger and more pointed. The light microscope appearance is shown in Figure 1f (left) with the insertion end to the top. Scales range from  $14 \times 11.5 \mu\text{m}$  to  $43 \times 28 \mu\text{m}$ . Occasional narrower oval scales are visible on the SEM, projecting from amongst the others, these may be the stalked spicules shown in Figure 1f (right) which measure  $24 \times 6.5 \mu\text{m}$  to  $51 \times 15 \mu\text{m}$ . The margins of the ventral groove are slightly raised, and bear two rows of spicules which are longer oval/lanceolate scales. They are attached by a stalk-like extension of the proximal end (Fig. 1g) and therefore project further than the lateral scales; the stalks are only visible when detached from the body. The stalks are eccentric, short and curved with a characteristic horizontal ledge below the stalk. The ventral groove spicules measure  $37 \times 10 \mu\text{m}$  to  $41 \times 11.5 \mu\text{m}$ .

*Internal anatomy:* The radula is minute or absent. Four or five specimens were examined in order to determine the form of the radula, but a distinct structure could not be identified. The head section of one large specimen was dissolved in hypochlorite solution but despite continuous observation during this process no radula could be found. Cleared whole-mounted specimens which were examined showed no sign of sclerotized chitin in the relevant areas. A structure visible in wholemounds may represent a small radula, but other studies (above) could not confirm its presence.

Copulatory spicules were developed in one specimen (1991.019.02), visible when examined in a drop of glycerol.

The specimen examined was hermaphrodite. The ovary is located in a mid-dorsal position and the testis postero-ventrally. The ovary although ripe contained only 7–8 well developed ova, the largest of which measured  $194 \times 120 \mu\text{m}$ .

### Taxonomic Discussion of the Genus *Tegulaherpia*

*Material examined:* *Tegulaherpia myodoryata* holotype, NHMW 84497; *Tegulaherpia stimulosa* holotype NHMW 84496.



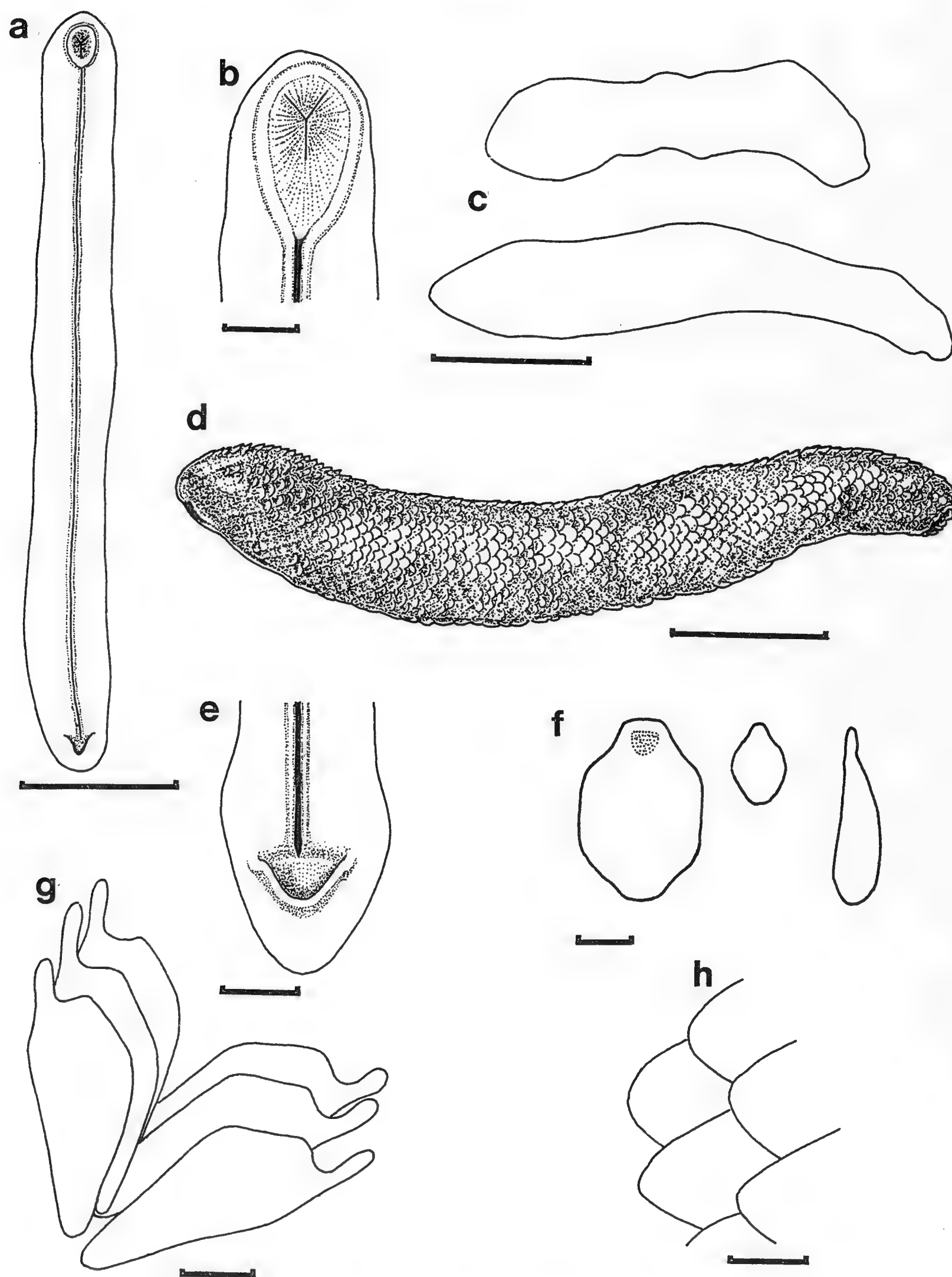


Fig. 1. *Tegulaherpia celtica* A. Ventral view of holotype; scale bar = 500µm. B. Oral opening of holotype; scale bar = 125µm. C. Outline drawings of two specimens showing variation in shape. Upper specimen from station 66; lower specimen from station 59b; scale bar = 500µm. D. Lateral view of holotype; anterior to left; scale bar = 500µm. E. Anal opening of holotype; scale bar = 125µm. F. Scales as seen on light microscope showing insertion ends and range in size (left two) and narrower stalked spicules (right); scale bar = 10µm. G. Stalked spicules from the ventral groove; scale bar = 10µm. H. Scales from the postero-lateral area *in situ* from SEM; scale bar = 10µm.

Three species of *Tegulaherpia* have been described to date; *Tegulaherpia stimulosus* Salvini-Plawen, 1983 from the Mediterranean in 53–112 m, *Tegulaherpia myodoryata* Salvini-Plawen, 1988 from Banyuls-sur-Mer and Livorno 75–105 m, and *Tegulaherpia tasmanica* Salvini-Plawen, 1988 from Northern Tasmania, 50–55 m. The present species was examined by Dr. Salvini-Plawen who identified it as conspecific with an undescribed *Tegulaherpia* species recorded from Bergen (Salvini-Plawen 1988) and at first thought by him to be juveniles of

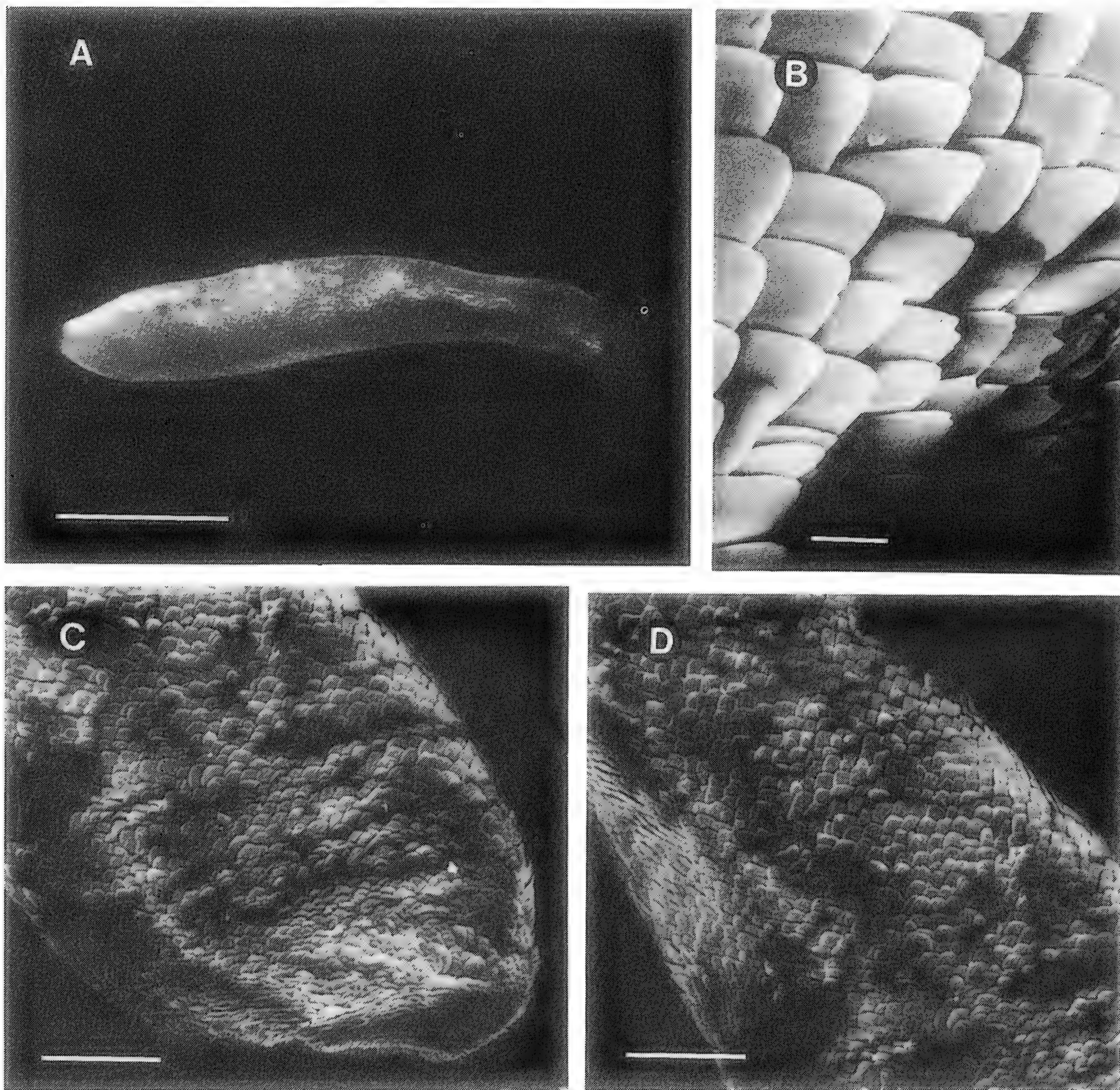


Plate 1. *Tegulaherpia celtica* A. Light micrograph of lateral view from the left side, specimen from station 59b; scale bar = 500µm. B. S.E.M. lateral body scales; scale bar = 10µm. C. S.E.M. anterior end of animal; scale bar = 100µm. D. S.E.M. mid-posterior lateral side of animal; scale bar = 100µm.

*Aesthoherpia glandulosa* Salvini-Plawen, 1985. *Aesthoherpia glandulosa* however differs from *Tegulaherpia* in having lanceolate, keeled scales which are considerably longer than those of *T. celtica*, measuring 50–225 µm in length.

*T. celtica* is more laterally compressed than *Tegulaherpia myodoryata* and possesses a more distinct dorsal keel. *Tegulaherpia stimulos*a is similar in the degree of lateral compression. Length/Breadth ratios for the three species follow; *T. myodoryata*, 5.8; *T. stimulos*a, 9.6; *T. celtica*, 7.6.

The radula of *Tegulaherpia stimulos*a measures about 40 µm in length and bears 5 medial denticles. The radula of *Aesthoherpia glandulosa* bears only 2 denticles; this species, also differs significantly in scale shape and size (Salvini-Plawen 1988).

Presently the evidence suggests that *T. celtica* may differ from other *Tegulaherpia* species in the absence of a radula. However it remains possible that a small structure is present but



could not be isolated from the rather few large specimens available for study. Further studies, if more material becomes available, may be desirable to confirm this feature.

**Family Macellomeniidae** Salvini-Plawen, 1978

**Genus *Macellomenia*** Simroth, 1893

Type species: *Macellomenia palifera* (Pruvot, 1890)

*Type locality*: North of Port Vendres, Mediterranean, 80 m. on a steep muddy bottom.

*Diagnosis*: Body rather thick, without dorsal keel, ventral groove without fold, surface generally smooth, cuticle thin with hoe-shaped calcareous bodies. Radula single series, salivary glands with subepithelial glandular cells. Mantle cavity with large number of gill folds.

***Macellomenia* cf. *palifera*** (Pruvot, 1890)

(Fig. 2, a–g, and Plate 2, a–d).

Voucher specimen deposited: NMW.Z 1994.019.07 (SEM specimen, from station 3c).

*Station data from the 1989 Irish Sea survey*:-

Station	Date	Gear	Position	Depth (m)	Substrate	No.
3c	10-7-89	grab	53° 19.8' N. 04° 59.9' W.	80	sand/gravel	1
6b	10-7-89	grab	53° 03.2' N. 05° 10.1' W.	120	shell gravel with mud	1

*Description*: The body is short, broad and rounded in section, without dorsal keel, the voucher specimen measuring (length  $\times$  breadth) 5.6  $\times$  3.0 mm. in size. The animal is characteristically contracted in a semi-coiled position in preserved specimens and has a generally 'spiny' appearance caused by the covering of 2 types of long, slightly curved projecting calcareous spicules (Fig. 2b; Pl. 2a). The spicules appear sparsely distributed since some of them (Type 1) emerge from broader bases. Most of the Type 1 spicule shafts were broken away in the specimen examined, leaving only these bases whilst the spicules visibly projecting are Type 2 simple serrated spicules. A ventral groove extends from the pedal pit to the base of the cloaca. No copulatory spicules seen. The cloaca is strongly ridged on the inner surfaces forming a series of folds. The oral pit (Fig. 2a) is inset and situated antero-ventrally. A postero-dorsal sense organ is situated just dorsal to the mantle cavity; it is triangular and indented in shape (preserved specimen) and devoid of spicules.

The cuticle is covered with the broad papilla-like bases of Type 1 spicules (the "hackenförmigen" – hoe-shaped spicules as described by Thiele, 1913) which characterize the genus. These are composed of a swollen papilla-like base from which a tapering pointed shaft emerges subterminally at an angle (Fig. 2e–f and Pl. 2c–d). The shaft is solid, curved and without serrations while the base is hollow with a matrix-like internal structure (Pl. 2d). Type 1 spicules are very fragile and normally broken off in the specimens examined (Pl. 2c) leaving a sub-terminal aperture in the base (Pl. 2c). Type 2 spicules are slightly curved, tapering, pointed spicules with rough, minutely serrated shafts. They measure 60–80  $\mu\text{m}$  long  $\times$  6–8  $\mu\text{m}$ . broad. Type 2 spicules are solid throughout their length, and in the specimens examined were better preserved than those of Type 1 (Fig. 2g and Pl. 2b). The two spicules types are intermixed over the cuticle, the Type 2 spicules emerging from between the bases of Type 1 (Pl. 2c). It is Type 2 spicules which are principally visible projecting from the figured specimens from between the Type 1 bases.



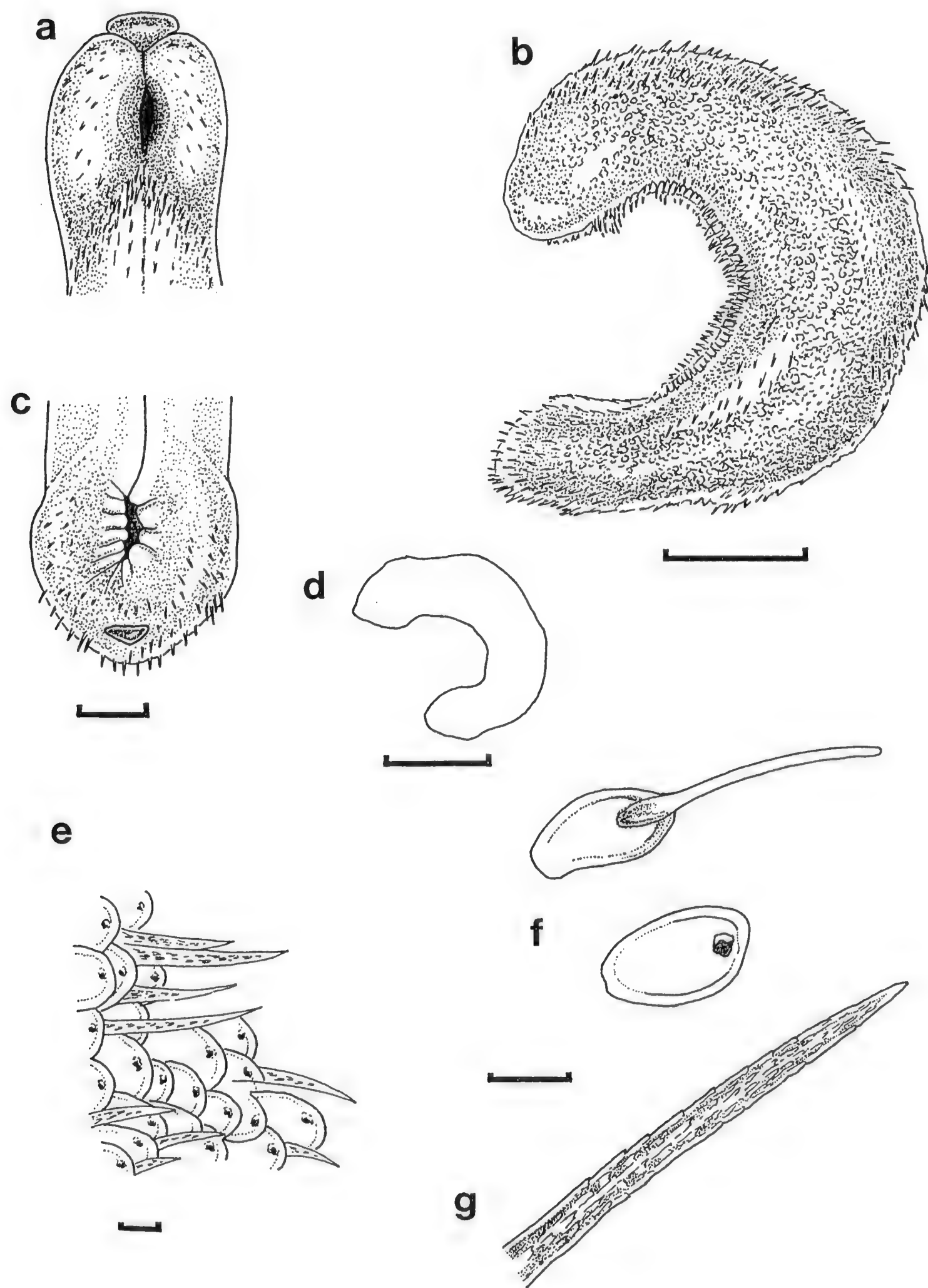


Fig. 2. *Macellomenia* cf. *palifera* A. Ventral view of oral opening of voucher specimen; scale bar = 100 $\mu$ m. B. Lateral view of voucher specimen; scale bar = 500 $\mu$ m. C. Ventral view of cloacal opening of voucher specimen, showing respiratory folds and dorsal sense organ; scale bar = 100 $\mu$ m. D. Outline drawing of smaller specimen from station 6b; scale bar = 1.0mm. E. Spicules of two types as they appear *in situ*; scale bar = 10 $\mu$ m. F. Type 1 spicules showing base with projection broken off (below) and intact (above); scale bar = 10 $\mu$ m. G. Type 2 spicule showing minute serrations; scale bar = 10 $\mu$ m.

#### Taxonomic Discussion of the Genus *Macellomenia*

No comparative material could be obtained. Dr. P. Bouchet has informed us that apparently none exists in the MNHN Paris or at Laboratoire Arago at Banyuls where Pruvot once worked. Dr. Salvini-Plawen has also searched for material at the latter and confirms that none could be found.

*Macellomenia* is a monotypic genus and was described from a single specimen in Pruvot's original study. This measured 8 mm long  $\times$  0.7 mm broad and was observed to be capable of reducing its length by half when contracted. It was further established (Pruvot 1891) that

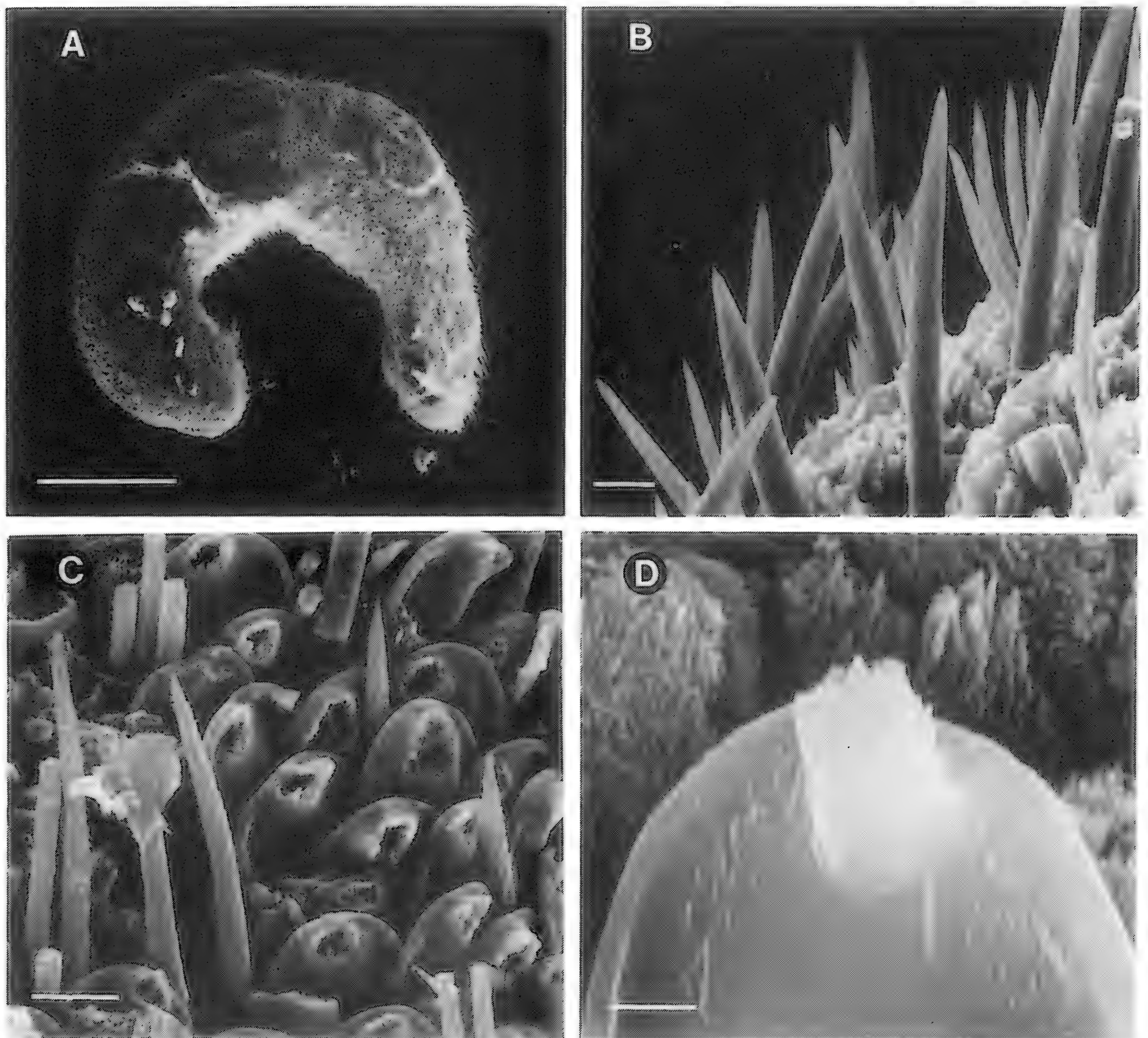


Plate 2. *Macellomenia* cf. *palifera* A. S.E.M. lateral view of left side of voucher specimen. Scale bar = 500 $\mu$ m. B. Type 2 spicules with minutely serrated surface; scale bar = 10 $\mu$ m. C. Bases of Type 1 (hoe-shaped) spicules, the terminal hole is formed where the spicule has broken away from the base; scale bar = 10 $\mu$ m. D. Type 1 spicule base with solid base of spicule attached; scale bar = 2 $\mu$ m.

there are 18 cloacal gills, the salivary glands are well developed and the radula extremely small. *M. palifera* has previously only been recorded from the type locality in the Mediterranean. Our specimens have been referred to this species because of the presence of the particularly characteristic 'hoe-shaped' spicules. No important differences were found that would merit specific separation from *M. palifera* at the present state of knowledge. Although a different spicule type (Type 2 spicules) were found in our specimens, it seems possible that these could have been overlooked in the original description of Pruvot. It was not apparent to us that two types were present until examining the specimen on the S.E.M.

**Family Pararrhopaliidae** Salvini-Plawen, 1978

**Genus *Pruvotina*** Cockerell, 1903

Type species: *Pruvotina impexa* (Pruvot, 1890)

*Type locality*: Banyuls-sur-Mer, Mediterranean, 80 m.



*New diagnosis:* (Salvini-Plawen, 1978): Body with thick cuticle. Spicules hollow, needle shaped and hooked. Oral aperture with atrium combined and spicellose groove. Radula distich with dorsal papillary gland. Ventral gland organ Type A (Salvini-Plawen 1978) with excretory duct. Midgut with lateral pouch. Origins of cerebral connective separate. Dorso-terminal sense organ present; secondary genital opening not paired; a pair of dorsal seminal receptacles. Cloacal respiratory folds present.

***Pruvotina* sp.**

(Fig. 3 a–g)

Voucher specimen deposited: NMW.Z 1994.019.08

*Station data from the 1989 Irish Sea survey:-*

Station	Date	Gear	Position	Depth (m)	Substrate	No.
6b	10-7-89	grab	53° 03.2'N. 05° 10.1'W.	120	shell gravel with mud	1

*Description:* Body of moderate size, rounded in section, narrowing anteriorly and truncated posteriorly, without a dorsal keel. The only specimen (Fig. 3a–c) measures 8 mm long  $\times$  1.35 mm broad with a prominent ventral groove. The body is contracted into a strong circular coil with the anterior and posterior ends almost overlapping. The cloaca is terminal protected by a number of long terminal spicules which fold towards the midline in contracted state. The oral aperture and atrium are combined and capacious. Animal with generally 'hairy' appearance caused by some spicules projecting beyond the others. Spicules of two major types. Type 1 spicules are hollow, needle-shaped, flexuously curved with a small knob at the insertion end. Type 1 spicules (Fig. 3d) are most numerous and found all over the body and vary in length, being shorter around the ventral groove; they measure up to  $230 \times 13.5 \mu\text{m}$  in lateral areas. The arrangement of Type 1 spicules (Fig. 3g) is diagonal and overlapping, they lie in more than one layer and intersect at approximate right angles. Type 2, hooked spicules project from between the latter. Type 2 spicules (Fig. 3e) measure up to  $150 \times 7 \mu\text{m}$  have a hollow flexed shaft with an acutely re-curved hook which bears a small blunt process at the point of curvature and a small insertion knob as above. Pedal groove spicules are knife-shaped and solid, (Fig. 3f), measure up to  $68 \times 15 \mu\text{m}$  and are found in a single row along each side of the ventral groove margins.

*Internal Anatomy:* Respiratory folds present in the mantle cavity, formed by a series of 15–20 sharp ridges of the cloacal wall. The cuticle is thick and contains the epidermal papillae which characterize the order Cavibelona. Longitudinal musculature is well developed suggesting a considerable ability to alter the body size. Despite careful dissection and mounting of the anterior region a radula could not be located. It seems likely that the radula, if present, is represented by a very small distich structure which was transparent or obscured by other structures when mounted, as a distich radula has been described in other *Pruvotina* species by Salvini-Plawen (1978).

*Taxonomic Discussion of the Genus Pruvotina*

Eight species of *Pruvotina* are known from the Antarctic, many of them from depths of 500–1000 m. (Salvini-Plawen 1978). In view of the geographical separation and habitat difference it seems unlikely that our specimen belongs to one of these species. Only one species is known from Europe, *P. impexa* Pruvot (1890) described from the Mediterranean.

No comparative material of *P. impexa* has been located. It would have been expected to be deposited either at the Laboratoire Arago at Banyuls-sur-Mer, or the MNHN, Paris, but inquiries (as above for *M. palifera*) have proved negative. The original specimens of Pruvot are therefore assumed to be lost.



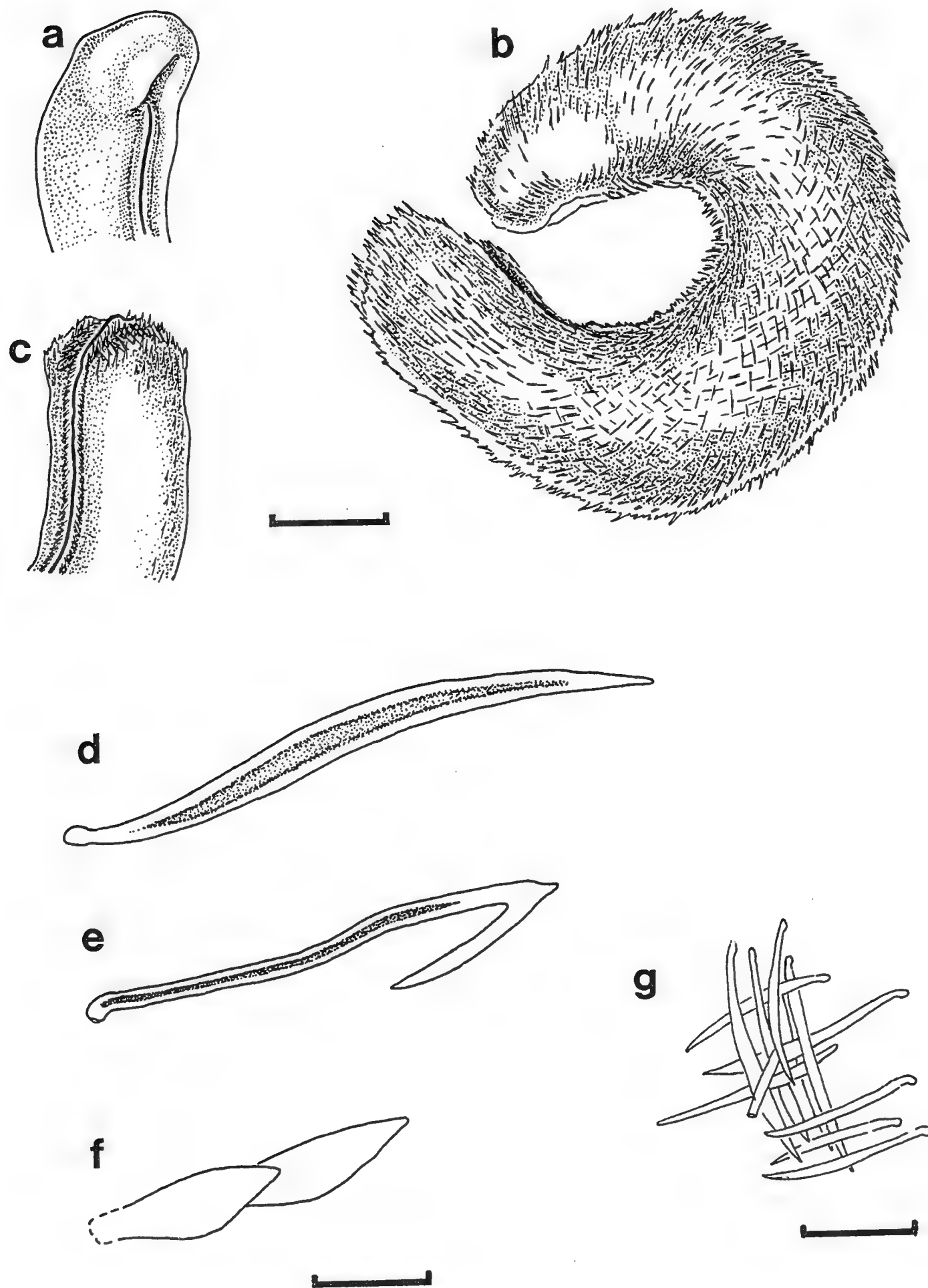


Fig. 3. *Pruvotina* sp. A. Ventro-lateral view to show oral opening and ventral groove of voucher specimen from station 6b; scale bar = 1.0mm. B. Lateral view of voucher specimen; scale bar = 1.0mm. C. Ventro-lateral view of caudal region of voucher specimen, showing ventral groove and tail spicules around cloacal opening; scale bar = 1.0mm. D. Type 1, needle-shaped spicule with small insertion knob to left; scale bar = 25 $\mu$ m. E. Type 2, hooked spicule; scale bar = 25 $\mu$ m. F. Type 3, knife-shaped spicules from edge of ventral groove; scale bar = 25 $\mu$ m. G. Detail of Type 1 spicules on lateral body area *in situ*; scale bar = 100 $\mu$ m.

Our specimen has been assigned to the genus *Pruvotina* Cockerell, 1903 on the basis of the absence of copulatory spicules, possession of hollow needle-shaped spicules in more than one layer and hooked spicules, presence of cloacal respiratory folds, and the generally 'hairy' appearance characteristic of the family Pararrhopaliidae. These features have been defined by Salvini-Plawen (1978). Although the spicule characteristics of *Pruvotina* species resemble those of *Eleutheromenia sierra*, the latter species possesses a characteristic strongly developed crest-like dorsal keel which is unmistakable, especially in largish specimens. Personal observations (CMC & AMJ) have shown that, in addition, *Eleutheromenia sierra* specimens from the Irish Sea possess spicules bearing bluntly serrated tips in addition to the other types already described, and that serrated spicules are lacking in the *Pruvotina* sp.

*P. impexa* resembles the present species in size, spicule characteristics and number of gill folds, but differs apparently only in its inability to coil up. The species was figured in Pruvot, 1891 and the figure suggests a more abruptly truncated anterior end in *P. impexa*, but the state of the contraction of the animal could influence this feature. Pruvot (1891) states that *P. impexa* is 'incapable de s'enrouler' despite examining 20 specimens, both live and preserved. This feature could reflect a significant difference in the musculature and locomotory abilities of the live animal. A search for new specimens of *P. impexa* from the type locality is necessary in order to ultimately settle this question. We conclude that our specimen, whilst evidently a *Pruvotina* species, cannot be positively identified. The possibility exists that it could be *P. impexa*.

## DISCUSSION

*Tegulaherpia* species are a relatively uniform group with characteristically a small body size and a covering of small scales rather than spicules. The radula is reduced to a paired distich structure. Salvini-Plawen has noted that the body musculature is not well developed and that the animal does not usually coil up in preserved specimens. It seems likely that the reduced musculature is related to their mode of locomotion. Sliding along a mucus thread using the ciliary and muscular activity of the ventral groove has been described in other Solenogastres, for example small species of the gymnomeniid genus *Genitoconia* are thought to crawl by a gradual snail-like sliding of the ventral body surface along a fine mucus thread which is secreted from the pedal groove (Salvini-Plawen 1967). *Tegulaherpia* belongs to the order Pholidoskepia, all of which are small and many are regarded as meiofaunal, feeding carnivorously on cnidaria; for this reason they may have often been overlooked. Salvini-Plawen (1988) has described several other meiofaunal solenogaster species from Bergen and the Mediterranean.

The depths at which *T. celtica* was found are compatible with those recorded for *Tegulaherpia stimulosa* (75–80 m), *T. myodoryata* (75–105 m) and *T. tasmanica* (50–55 m). There is little data available as to substrate for these species. It appears therefore that *Tegulaherpia* is a genus occurring at moderate depths and in cool waters on silty sand or shelly gravel substrates, sometimes with mud. It may be expected and could be looked for in similar habitats around western Britain.

The present material of *M. cf. palifera* and *Pruvotina* sp. were obtained from bottoms of sandy gravel and shell gravel with mud, at depths of 80–120 m. Pruvot's specimen of *M. palifera* was also from 80 m on a steep muddy bottom and was observed alive climbing on a tube of the sabellid polychaete *Myxicola infundibulum*. Whether this association was of any particular significance is not known; the samples had probably been disrupted during sieving or sorting before the observation was made. *Pruvotina impexa* was obtained by Pruvot in larger numbers (20 individuals) from muddy sediment containing various hydroids and bryozoans on which the specimens were actively climbing. It appears from the species recorded from both the Mediterranean coast near Banyuls-sur-Mer and those obtained during the Irish Sea Survey that there are at least 5 solenogaster species in common to both areas.

It is interesting to note that other meiofaunal solenogaster species have been found from the British area as recorded by Boaden (1966) in a study of interstitial fauna from Strangford Lough where the species *Lepidomenia hystrix* Marion & Kowalevsky in Fischer, 1885 was recorded. *Lepidomenia hystrix* may only be known from the type locality (the north coast of the island of Ratonneau near Marseilles) as discussed in Heppell (1990) and Boaden's species is listed as *Lepidomenia* sp. in Smith & Heppell (1991). This species was recorded from two sites

just outside Strangford Lough, at station 1, at a depth of 25 m on medium shell gravel and also at station 3 in an intertidal pocket of fairly coarse shell gravel on a small island at the seaward entrance to the Strangford narrows. Boaden states that in addition to the *Lepidomenia hystrix* 'at least four undescribed solenogasters occur' at station 1; two of these were also collected at station 3. Many normally sub-littoral species were said to occur at the intertidal station. Further searches of shell gravel habitats around Britain may reveal additional species.

For identification of marine survey samples, classification of the Solenogastres using internal anatomical features such as the salivary and midgut glands has not always been found practical, especially when only a small number of individuals are available for study. There would therefore be a major advantage in using spicule shape and other features of the external body morphology whenever possible for identification. The spicules are accessible and a number of them can easily be removed from a specimen; this can be done quickly and with a minimum of preparation on a compound microscope. Spicules dissolve easily in acidic preservatives such as formaldehyde and particular care must therefore be taken in buffering solutions in which specimens are to be fixed or stored.

#### ADDITIONAL NOTE

During the present study, examination of one specimen (thought originally to be *T. celtica* from station 59) in sodium hypochlorite, resulted in the isolation of spicules belonging to a separate species, resembling *Micromenia fodiens* (Schwabl, 1955). This species has been reported from Raunefjord, Bergen by Salvini-Plawen (1988). Preliminary evidence therefore suggests that the species may also be present in the Irish Sea. Further collections would be needed to confirm this.

#### ABBREVIATIONS USED IN TEXT

NHMW Naturhistorisches Museum, Wien  
 NMW.Z National Museum of Wales, Zoology, Cardiff  
 MNHN Muséum National d'Histoire Naturelle, Paris

#### ACKNOWLEDGEMENTS

We should like to thank Dr. Salvini-Plawen for looking at the *Tegulaherpia* species, David Heppell of the National Museums of Scotland, Edinburgh for literature help and comments, the late Dr. E. Wawra for specimens from Vienna, Liz Müller for German translation, Dr. P. G. Oliver and A. Trew for specimens from Wales, Dr. P. Bouchet for checking up on Pruvot's specimens and Rachel Morris, Dundee University for photographic assistance. The Irish Sea survey was co-ordinated by A. S. Y. Mackie of the National Museum of Wales.

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# COMMUNICATIONS

## INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

*Applications published in the Bulletin of Zoological Nomenclature.*

The following Applications were published on 30 September 1994 in Vol. 51, Part 3 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publications in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

### Case 2904

#### ***Nesopupa* Pilsbry, 1900 (Mollusca, Gastropoda): proposed conservation**

Robert H. Cowie, Carl C. Christensen & Neal L. Evenhuis  
*Bishop Museum, P.O. Box 19000A, Honolulu, Hawaii 96817–0916, U.S.A.*

**Abstract.** The purpose of this application is the conservation of the name *Nesopupa* Pilsbry, 1900 for a genus of land snails by the suppression of *Ptychochilus* Boettger, 1881, an unused senior objective synonym.

### Case 2902

#### ***Acanthoteuthis* Wagner in Münster, 1839 and *Kelaeno* Münster, 1842 (Mollusca, Cephalopoda): proposed conservation of usage**

D. T. Donovan  
*Department of Geological Sciences, University College London, Gower Street, London WC1E 6BT, U.K.*

**Abstract.** The purpose of this application is to conserve the current usage of the names *Acanthoteuthis* Wagner in Münster, 1839 and *Kelaeno* Münster, 1842 for two genera of Jurassic teuthoid coleoids. In 1839 Münster had mentioned the name *Kelaeno* as synonymous with *Acanthoteuthis* but had not made it available. In 1841 d’Orbigny used the name *Kelaeno* in Münster’s (1839) sense, but in 1842 Münster used the name for a different taxon which conforms with current usage. Suppression of *Kelaeno* d’Orbigny, 1841 is proposed.

### Case 2866

#### **MEGALODONTIDAE Morris & Lycett, 1853 (Mollusca, Bivalvia) and MEGALODONTIDAE Konow, 1897 (Insecta, Hymenoptera): proposed removal of homonymy**

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**Abstract.** The purpose of this application is to remove the homonymy between two family names of Hymenoptera and fossil Bivalvia. It is proposed that the complete name of the sawfly genus *Megalodontes* Latreille, 1802 be adopted as the stem of the corresponding family-group names, giving MEGALODONTESIDAE Konow, 1897. The mollusc name MEGALODONTIDAE Morris & Lycett, 1853 would remain unchanged.

### *Opinions published in the Bulletin of Zoological Nomenclature*

The following Opinions were published on 30 September 1994 in Vol. 51, Part 3 of the *Bulletin of Zoological Nomenclature*. Copies of these Opinions can be obtained free of charge from the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

OPINION 1779. *Potamolithus* Pilsbry & Rush, 1896 (Mollusca, Gastropoda): placed on the Official List with *Paludina lapidum* d’Orbigny, 1835 as the type species.

OPINION 1780. *Turbo politus* Linnaeus, 1758 (currently *Melanella polita*; Mollusca, Gastropoda): usage of the specific name conserved, so conserving the specific name of *Buccinum acicula* Müller, 1774 (currently *Ceciloides acicula*).

*Applications published in the Bulletin of Zoological Nomenclature.*

The following Applications and Open Opinions were published on 30 March 1995 in Vol. 52, Part 1 of the *Bulletin of Zoological Nomenclature*.



**Case 2949**

***Aplysia juliana* Quoy & Gaimard, 1832 (Mollusca, Gastropoda): proposed conservation of the specific name**

E. Martinez & J. Ortega

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**Abstract.** The purpose of this application is to conserve the specific name of *Aplysia juliana* Quoy & Gaimard, 1832 for a sea hare (Opisthobranchia, Anaspidea) found worldwide on rocky shores in warm waters. The name is threatened by the unused senior subjective synonym *A. sorex* Rang, 1828.

**Case 2922**

***Octopus vulgaris* Cuvier, [1797] and *Loligo vulgaris* Lamarck, 1798 (Mollusca, Cephalopoda): proposed conservation of the specific names**

Angel Guerra

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Miguel A. Alonso-Zarazaga

*Museo Nacional de Ciencias Naturales (CSIC), José Gutiérrez Abascal 2, 28006 Madrid, Spain*

**Abstract.** The purpose of this application is to conserve the specific names of both the common octopus *Octopus vulgaris* Cuvier, [1797] and the common squid *Loligo vulgaris* Lamarck, 1798. The names of these economically important species are threatened by senior subjective synonyms unused in the past century, *Sepia octopodia* Linnaeus, 1758 and *S. octopus* Gmelin, [1791] (octopus) and *S. loligo* Linnaeus, 1758 (squid).

OPINION 1792. *Pleurotoma meneghinii* Mayer, 1868 (currently *Asthenotoma meneghinii*; Mollusca, Gastropoda): neotype replaced by rediscovered lectotype.

OPINION 1793. *Chtenopteryx* Appelöf, 1890 (Mollusca, Cephalopoda): confirmed as the correct original spelling.

## A NEW DISCOVERY OF THE MIDDLE PLEISTOCENE 'RHENISH' FAUNA IN ESSEX

A distinctive assemblage of freshwater molluscs occurs in certain fluvial deposits of Middle Pleistocene age in eastern England and on the continental mainland. This assemblage includes two extinct species, *Theodoxus serratilineiformis* (a member of the *danubialis* group) and *Viviparus diluvianus*, together with more familiar taxa such as *Valvata naticina*, *Corbicula fluminalis*, *Belgrandia marginata* and *Pisidium clessini* (the last also extinct). Kennard (*Proc. Geol. Ass.* **53** (1942), 24–25, 105) suggested that the arrival of these species in England occurred after the Thames and Rhine drainage systems had become linked. Ironically, *T. serratilineiformis* is as yet unknown from Rhine deposits of this age, but was present in other systems such as the Scheldt.

In Britain this so-called 'Rhenish' suite of molluscs has hitherto been found at only two sites. At Barnfield pit, Swanscombe, Kent (TQ 597742), they are absent from the earliest fluvial deposits (Lower Gravel) and first appear, very rarely, towards the top of the overlying Lower Loam but become especially common at the base of the Lower Middle Gravel (Kerney, M.P. *J. geol. Soc. Lond.* **127** (1971), 69–93). This 'Rhenish' assemblage has also been discovered at two neighbouring sections at Swanscombe, at Dierden's (or the Ingress Vale) pit (TQ 595748) and at Rickson's pit (TQ 608743), which have consequently been correlated with the upper levels of the succession at Barnfield pit (Kerney *op. cit.*).

At Clacton-on-Sea, Essex (TM 171141), estuarine clays and silts overlie fluvial sands, which are thought to belong to the same interglacial as at Swanscombe. *Belgrandia marginata* first appears towards the top of the freshwater beds and other members of the 'Rhenish' fauna, including *V. diluvianus* and *C. fluminalis*, occur as drifted shells in the estuarine beds. Unlike the sediments at Swanscombe, those at Clacton are polleniferous and it has been possible to relate the molluscan succession to a pollen zonation. Thus the 'Rhenish' elements occur predominantly in the estuarine beds deposited during the late temperate sub-stage (Ho IIIb) of the Hoxnian interglacial (Turner, C. & Kerney, M. P. *J. geol. Soc. Lond.* **127** (1971), 87–93).

This preliminary note records the occurrence of the 'Rhenish' fauna at a third site in Britain. As part of a Ph.D research programme, a borehole (EH 1) was drilled through the infill of a buried channel at East Hyde near Tillingham, Essex (TL 98040407), about 20 km SW of Clacton (Roe, H. M. (1994) *Pleistocene buried channels in eastern Essex*, Unpublished Ph.D thesis, University of Cambridge). The channel, (first discovered by Lake, R. D. *et al.* 1977, *Report of the Institute of Geological Sciences*, No 77/21), extends some 2 km north and south of East Hyde, and is associated with terrace gravels attributed to the late Middle Pleistocene Thames-Medway river (cf. Bridgland, D.

## COMMUNICATIONS

R. *Proc. Geol. Ass.* **99** (1988), 291–314). The sediments filling the channel were fossiliferous, indistinctly laminated sandy silts. Fluvial molluscs were recovered between 8·18–10·20 m O.D. and included several members of the ‘Rhenish’ fauna (*Theodoxus serratilineiformis*, *Viviparus diluvianus*, *Corbicula fluminalis* and *Pisidium clessini*). Associated taxa included *Bithynia tentaculata*, *Pisidium moitessierianum*, *P. nitidum*, *Discus* cf. *runderatus* and unionid fragments. Several brackish-water species were also present including some hydrobiids (species identity uncertain), *Cerastoderma edule* and the ostracod *Cyprideis torosa*. Pollen spectra from these levels contained high frequencies of *Abies*, *Pinus* and *Alnus* indicating correlation with sub-stage Ho IIIb of the Hoxnian (cf. Turner, C. *Phil. Trans. R. Soc. Lond.* **257** (1970), 373–440).

The site of East Hyde therefore appears to be identical in age to the estuarine beds at Clacton and, by extension, to the upper levels of the Swanscombe aggradation. It has recently been suggested, from amino acid evidence, that Clacton and Swanscombe belong to oxygen isotope stage 11 and are older than the lacustrine deposits at the Hoxnian type site at Hoxne, Suffolk, which have been attributed to stage 9 (Bowen, D. Q. *et al.*, *Nature, Lond.* **340** (1989), 49–51). This suggestion requires further testing. Amino acid ratios from East Hyde should establish the validity of our correlation. A full report on this important site will appear elsewhere.

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## MAIZANIA KAZIBAE ADAM (GASTROPODA, PROSOBRANCHIA, MAIZANIIDAE) IN UGANDA

Coming across Adam’s description and figure of *Maizania kazibae* (Adam, W., *Bull. Inst. r. Sci. nat. Belg. Biol.* **57** (1987) pp. 91–95) described from Zaire, Parc National de l’Upemba, Kaziba (9°09’ S, 26°57’ E) and Kilwezi (9°05’ S, 26°45’ E) and characterized by its elevated shape, I remembered Mrs McMillan had sent me something similar from the Liverpool collections. The material, five specimens, had been collected by C. R. S. Pitman in Uganda (1965.141), SW. Ankole along the R.Kagera (about 0°57’ S, 30°22’ E). When I first examined it, I had been content to consider it an unusually elevated variety of *M. volkensi* (von Martens), but study of Adam’s figure suggested it could well be *M. kazibae*. I therefore reborrowed the material from Liverpool and, although some 950 km to the north, I am now confident the Pitman specimens can be referred to *M. kazibae*. Adam’s species was based on 417 specimens (mostly collected alive and preserved in spirit) and has the apical whorl prominent; Adam mentions that in most of the specimens the body whorl is very slightly detached near the aperture. The Pitman material has a similar apical whorl but only one worn specimen of the five shows any traces of detachment. A survey of the sparse material of *M. volkensi* in the British Museum (Nat.Hist.) shows variation in the ratio of height to breadth of the shell. One lot of two specimens (BM 1913.7.31.155–156) collected in the Mathews Range, Kenya on Mt. Warges (Urguess, Uaragess etc.) by the game warden Blayney Percival, which Preston had intended to name after him, is more elevated than usual but not quite so much as the Pitman material and the apical whorl is not so produced. Nevertheless it hints that further material from intervening localities might show that *M. volkensi* and *M. kazibae* are not as distinct as Adam thought.

One further specimen should be mentioned for completeness. When describing *M. marsabitensis* (Verdcourt, *Arch. Molluskenk.* **92** (1963) pp. 15–17, figs. 1,2) I mentioned a single specimen resembling *M. volkensi* with an elevated acute spire measuring 6 x 5 x 4.2 mm I had found on Mt. Marsabit. This will, I am certain prove to be the same form as that from Mt. Warges, but the specimen is in Nairobi and not easily available to me.

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## BOOK REVIEWS

*Australian marine Shells: prosobranch gastropods*, part 1. By Barry Wilson, with illustrations by Carina Wilson and photography by Patrick Baker, 1993. Kallaroo, WA, Odyssey Publishing. 408 pp, including 44 full page colour plates. Hardback. ISBN 0–646–15226–2. Price £57.00 (obtainable in the UK from Wheldon & Wesley Ltd, Codicote, Hitchin, Herts SG4 8TE).

In the words of its own Introduction, ‘this volume is the first of two which gather together current information about Australian marine prosobranch molluscs and describe and illustrate their shells as an aid to identification for the purposes of business or pleasure’. Part two will deal with the neogastropods (Muricoidea, Cancellarioidea and Conoidea). The present part includes the remaining orders of prosobranchs, following the most recent classification so that the three ptenoglossan superfamilies Triphoroidea, Janthinoidea and Eulimoidea come at the end of the book. The Heterobranchia are ranked as a separate subclass, so the families Architectonicidae, Valvatidae, Rissoellidae and Pyramidellidae are not included here.

The introductory section includes hints on shell collecting (with heavy emphasis on conservation), a select bibliography of books illustrating Australian shells, a list of shell magazines and ‘technical’ journals (which omits the *Journal of Conchology*!) and a section on classification and nomenclature. This last may be faulted where it states, erroneously (p. 24), that if an author did not designate a type species for a generic name ‘the first one which appears after the new name automatically becomes the type species’, and that precedence in the case of simultaneously published synonyms is determined by page priority, which is contrary to the ‘first reviser’ provision of the International Laws of Nomenclature [sic]. In the systematic part of the book, each superfamily and family has a descriptive introduction, with references to recent taxonomic revisions. The genera, each with a note of its type species and geographical range, are arranged alphabetically within their families; the species, alphabetical within genera and subgenera, are individually described in most cases, and may have an indication of size, distribution, habitat and synonymy. Most species are illustrated, with a coloured photograph for the larger species and a line drawing for the smaller ones. So much for the objective description of the book, but does it live up to its promise? I must admit to some disappointment on two counts, the design of the book (over which the author possibly had little control) and the scientific content.

The book is awkward to use as it is both large (A4 format) and heavy (printed on ‘art’ paper, so coloured illustrations can be scattered throughout). Occasionally this scattering is appropriate, as with the excellent photographs of living molluscs on the pages of captions facing the colour plates of shells, but in other cases it is merely irritating as when uncaptioned cut-outs of shells are used to embellish the contents and introductory pages, with the text contoured round them. At worst (p. 20) a splendid species of *Calliostoma* or *Astele* is illustrated in two views; as there is no reference to it from the text and it does not occur among the plates, the frustrated reader is left to wonder whether it is an Australian species or not, especially as it bears a close resemblance to the West Atlantic *C. schroederi*. The index pages are similarly peppered with ‘re-cycled’, though captioned, drawings.

According to the author, the main use of this book ‘will probably be as an aid to identification of specimens’. In this aim the book is largely successful, and a welcome addition to the rather limited number of serious works on the extensive Australian malacofauna. It must be said, however, that identification would have been helped by more markers (verbal or pictorial) to the characters that distinguish one species from another, especially in speciose families such as the Epitoniidae or Ranellidae. The colour photography is of superb quality, but sometimes the individual illustrations are just too small (e.g. Trochidae) to show sufficient detail for confident identification. The drawings of the smaller species are less successful and in difficult groups, such as the Triphoridae, are rather inadequate. Many of the terms used in the descriptions of the species are not included in the 6-page glossary (e.g. teleoconch, plicae, fenestrate).

From its title (and price!) the reviewer expected this volume to be at least as comprehensive (within its taxonomic limits) as Powell’s *New Zealand Mollusca* or Keen’s *Sea Shells of tropical West America*, but in fact the author has given short measure in several groups where there has been no recent revision. For some (e.g. Triphoridae, Eulimidae) only representative species of each genus are mentioned, while for the Skeneidae only one species is illustrated to represent the entire family. Less excusably, for information on the 50-odd Australian species of Cingulopsidae and Eatoniellidae the reader is simply referred to the literature. For other families it is uncertain whether the coverage is comprehensive or not. A few particular shortcomings may be mentioned. All the ‘Acmaeidae’ included are currently Lottiidae; Risssoidea has been conserved for the name of the superfamily, rather than Truncatelloidea; some species of the masculine genus *Polinices* have been treated as feminine (*fibrosa* and *powisiana*); the figure of *Nerita undata* on p. 38 is labelled *Nertia undosa*; the smaller figure of ‘*Oxygyrus keraudrenii*’ on p. 254 does not show the characteristic keel, and looks more like a larval shell of *Carinaria*; *Melanella* and *M. dufresnei* [sic] (p. 286) were published by Bowdich, 1822, not 1832. It is a pity that neither the illustration nor the description of *Melanella dufresnii* distinguish it from many other *Melanella* species, as the Lizard Island locality would, if true, be an interesting extension of its range. Despite such limitations and minor criticisms, *Australian marine Shells* will be indispensable to the collector, curator or environmental administrator dealing with the marine prosobranchs of the

Australian faunal areas. Together with the second volume, which should be comprehensive for the neogastropods, it will undoubtedly become the standard work of reference.

DAVID HEPPELL

*Freshwater snails of Africa and their medical importance.* By David S. Brown. 2nd Edition, Taylor and Francis, 1994 (1st edition 1980). ISBN 0-7484-0026-5. x + 605 pp., 147 figs, price £85.

It is a great pleasure to see this revised edition of David Brown's *Freshwater snails of Africa and their medical importance* appear in print. The second edition follows the layout of the first but has been extensively re-written to provide a masterly up to date review. Above all, the book is immensely readable for although it is packed with pertinent facts Brown manages to present these in a lively and informative way which is easily understood and assimilated. The high quality of the text is matched by the production of the book. The binding, paper, print half tones, figures and layout are all of extremely good quality. Of course, such a product does not come cheap and it is unfortunate that the price at which the book sells will inevitably restrict its readership.

Approximately half the book deals with a systematic account of African freshwater snails and half with matters which could broadly be classed as ecological although this second half also includes the chapters on schistosomiasis. It is in the second half that the bulk of updated text is to be found. The systematic account gives keys to generic levels and figures and accounts at species level for all the African freshwater snails, including species from marginal habitats such as mangrove swamp. In all, some 400 species are dealt with. As mentioned above, the illustrations, which are predominantly found in this part of the book, are excellent and are also appropriately positioned within the text. This portion of the work contains a checklist and is concluded by a set of maps showing some distribution patterns.

Although Africa is a vast continent, embracing several climatic zones from the Mediterranean in the north through desert, lowland and upland tropics to the temperate uplands of southern Africa, the families Thiaridae and Planorbidae dominate the freshwater snail fauna. It is of course, the planorbiid genus *Bulinus* which is the subject of much of the second half of the book because of its pre-eminence as the intermediate host for schistosomiasis, the complexity of the forms and their distribution over all of the continent. Chapters include discussion of schistosome and other snail-transmitted diseases, the biology of *Bulinus* and snail control. More removed from the medical aspects are chapters on local snail faunas (including that of the great African lakes), chemical and physical factors, life cycles and populations and biogeography. It is in this second half, particularly, that Brown guides us with such ease through the complexities of the literature. I was disappointed that we hear no more of the parasite *S. hippopotami* than its mammalian host, fascinated by the accounts of polyploidy in *Bulinus* and its relevance to distribution and resistance to schistosome infection, and not surprised that the forms of *Bulinus* that are so variable in shell characters, appear to be as complex at the protein and DNA level. It appears that attempts to control schistosomiasis by using molluscicides have been unsuccessful but the use of molluscan predators of *Bulinus* offers an exciting possibility for control.

Only at one point did I feel that Brown's scholarship faltered and that was when discussing the relationship between equivalents, molarity and mg per litre of  $\text{Ca}^{++}$  and calcium bicarbonate where he suffers from the apparent convention that biologists have of writing  $\text{CaCO}_3$  (calcium carbonate) but talking of (calcium) bicarbonate. As a chemist the habit jars horribly in my mind and, as written, is in fact incorrect although it does not affect subsequent discussion in any way. Readers should also note that mM is already a unit of concentration i.e. moles per litre. However, this is a minor point and I recommend everyone who is interested in freshwater snails, their ecology and relevance to disease to buy the book.

David Brown is to be congratulated on this second edition of a classic work and no less praise go to the publishers for their excellent production.

BRIAN COLES

*British Prosobranch Molluscs: Their functional anatomy and ecology* (revised and updated edition) by Vera Fretter and Alastair Graham. Ray Society, London. ISBN 0-903874-23-7, 1994. xix + 820 pp, 343 figures. Hardback price £83.

The publication in 1962 of the first edition of *British Prosobranch Molluscs* marked a milestone in molluscan literature. Covering all prosobranchs (marine, freshwater and terrestrial) it provided the most comprehensive synthesis on the subject, much of which was based on the authors' own research. Vera Fretter's beautiful drawings were then and still are a valuable asset in the study of molluscan anatomy. For 30 years it has remained a standard textbook for all students of Mollusca from zoology undergraduates to professional malacologists.

Advances in recent years with the increased popularity of the Mollusca as a vehicle for research has meant that a proportion of the information in the 1962 work is incomplete and in some cases out-of-date. The decision to publish a new updated edition is therefore welcome. Although Vera Fretter died in October 1992, the bulk of the revisionary work had been done and the book was in the galley proof stage.



## BOOK REVIEWS

The result is a mixture of old and new. It now comprises 2 parts: Part I which is essentially the 1962 edition with a few minor changes. The original chapter on the excretory system has been deleted along with data on shell secretion, parasites and the appendices. Part II contains new chapters. The book is prefaced with notes on preparation and use of the book and nomenclature. The latter is necessary because the nomenclature in Part I has not been updated to equate with that used in Part II. For readers familiar with the changes in nomenclature in recent years this will not present too many problems (although many of the names in Part II do not concur with any one of the recent checklists). For those less familiar, the differences may well give rise to confusion. This is further compounded with aggregates such as the littorinids; in 1962 only 4 species were recognised whereas the extension chapter in Part II now refers to 8 species.

The Introduction to the revised edition has been completely rewritten and is based on the current concepts of evolution and classification. This is a very useful and readable summary of the evolution, phylogeny and adaptive radiation of the gastropods and their higher classification. Much of this is based on the work of the Austrian malacologists Salvini-Plawen and Haszprunar.

In Part II the new material is presented in 14 chapters. These chapters represent extensions of, or replacements for, several of the chapters in Part I taking into account new facts and ideas. These refer to alimentary anatomy and feeding; the endocrine, excretory and vascular systems; ecology, classification and relationships. At the end of each chapter there are cross-references to other chapters in Part II (see below). There is much of interest within these chapters particularly those for individual prosobranch families or species. There are separate accounts for littorinids, limpets, trochids and calyptraeids, hydrobiids, naticids and *Nucella lapillus*. All of these data may be found elsewhere but the presentation in this summary form with full referencing is very useful. In the *Nucella* section, for example, in addition to new anatomical information there is an account of all the recent studies on the effect of tributyltin (TBT).

The References spanning some 75 pages are invaluable yet it has been decided to split them into 2; those for Part I and those for Part II. If the References for Part II were all published after 1962 then this would appear logical, but as this is not the case then it would have been more appropriate to amalgamate them.

I have had a copy of the first edition for many years and although I refer to it often, it is an infuriatingly difficult book to use. The problem is that the information is difficult to access in spite of a subject index and a systematic index. My main use for the book is usually to obtain information on a particular species. However, the systematic index merely lists the page numbers for each species and the reader has to consult most of these pages to find the required information. Unfortunately much of the information contained in the new edition is even less accessible. In the new edition there is a general index only, which covers Parts I and II. The lack of systematic entries means that there is no easy way of getting information on a particular species. Similarly, the cross referencing in Part II only cross refers within Part II and not also with Part I. Notes in parentheses have been inserted in Part I to draw attention to chapters in Part II. Thus, to ensure that no information is missed, it is advisable to consult the relevant chapters in Part II before consulting Part I!

I regard the absence of detailed indexes in such a large volume as a major impediment to retrieving information and the revision to Part I is inadequate. This is a great pity and a little more editorial imagination could have foreseen and addressed these problems. There are several software packages available nowadays that would have enabled computer production of a comprehensive index and cross-referencing system which would have made this work much more user-friendly.

It would be easy to allow irritation with the production to detract from what is an indispensable malacological work that is likely to remain the standard for many years. Many members of the Conchological Society tend to be more interested in biogeography and taxonomy rather than physiology and it should be stressed that it is not the intention of this work to provide information on the former. However, if you only intend to have one reference work on the functional anatomy and ecology of this country's fauna, then *British Prosobranch Molluscs* is recommended for you. At £83 it is far from cheap and it is, therefore, a great incentive to join the Ray Society who offer it to Members for around half the price.

IAN KILLEEN

*A Field Guide to the Nudibranchs of the British Isles* by Bernard E. Picton and Christine C. Morrow. Immel Publishing (20 Berkeley Street, Berkeley Square, London W1X 5AE, 1994. Softbound, 143 pp, 115 colour photographs, 4 colour paintings, and 6 black & white figures. ISBN 1-898162-05-0. Price £15.95 × p&p.

This book is intended as a photographic guide for divers and underwater photographers, and in illustrating all British species, including a few unnamed ones, it achieves its aim. There is a short introduction, followed by a strong section on food and feeding. This lists all prey/predator relationships known to date for British species, tabulated with the nudibranchs taxonomically arranged and with sub-order diagnoses. Another table lists prey groups as the main heading, and gives the nudibranchs feeding on them worldwide. A brief chapter discusses reproduction, and there are useful sections on how to look for nudibranchs, recording schemes, conservation, and collecting/preservation techniques. The section on anatomy with tables and diagrams of rhinophore types is useful,



as is the glossary of technical terms for the non-specialists. The glossary of Latin names is fun and may help some remember the scientific names!

The bulk of the book is given to species descriptions, with text on the left and a photograph/illustration on the facing page. The descriptions are brief, highlighting diagnostic features, average and/or maximum sizes (although a number of species are missing size data). The second paragraph describes prey species and egg masses, while the third covers distribution around the British Isles and Europe. Many descriptions have an additional paragraph discussing similar species. Each species has two or three bullet points of key characteristics.

The list of 'Books on nudibranchs and other sea slugs' covers so many of the colour guides available to date that it is difficult to understand why Schmeckel & Portmann (1982), Cattaneo-Vietti, Chemello, & Giannuzzi-Savelli (1990), and Wells & Bryce (1993) are omitted (and the updated reprint of Behrens (1991)). This section is followed by half a dozen lines covering a few journals which publish opisthobranch research. The selection of 'authors of taxonomic papers . . .' is puzzling, and one wonders at its purpose. A simple index, including taxonomic and technical terms, concludes the book.

With all the recent photographic publications of sea slugs from various geographical regions, it was inevitable that one would soon appear on the British fauna. Photographic guides are useful in supplementing records of species, but cannot replace accurate, detailed drawings. The latter, especially in colour, have the advantage of showing more anatomical and colour detail, which is of value for identification purposes. However, Bernard Picton's expertise in identifying these creatures compensates for the possible queries in identification. However, the photographs on p. 90 of *Janolus hyalinus* and *Proctonotus mucroniferous* could easily be of the same species, whereas drawings could have emphasized the difference more clearly. The guide is based on the senior author's many years of working on the British marine sublittoral, and as such is a welcome addition to any library. Only nudibranchs are covered in the book, and all but a few are illustrated with colour photographs of living, crawling animals, often in their natural habitat or on their food, sometimes with spawn. It is a shame that there are not more pictures of spawn: Picton & Morrow state in their introduction that often the first sign of a nudibranch is its spawn, which they describe for the majority of species.

There are some errors, mostly minor irritations such as spelling errors, Latin with a small 'l'; flabellinids, aeolids, sagartiids with capital first letters; Linnaeus sometimes spelt out, sometimes abbreviated; etc. Another query is why *Eubbranchus* sp. A and sp. B are placed with the *Eubbranchus* in the main systematic treatment, but *Eubbranchus* sp. C is not. The same applies for the last four species with photographic records (two *Doto* spp., *Cadlina* sp., *Janolus* sp.), which would have been more usefully placed in their respective genera.

Overall, the book is to be highly recommended, with lovely photographs and useful ecological details of use to divers, marine biologists, and specialists.

NATALIE YONOW







## INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr P. G. Oliver, National Museum of Wales, Cathays Park, Cardiff CF1 3NP.**

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**COMMUNICATIONS** These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

# Journal of Conchology

Vol. 35, Part 3, June 1995

## Contents

	PAGE
PAPERS	
D. HEPPELL—The Identity of <i>Melanella dufresnii</i> Bowdich, 1822, and Other Species of Eulimidae (Gastropoda: Prosobranchia) Described Earlier	193
L. R. L. SIMONE and C. M. MARTINS— <i>Annulobalcis aurisflamma</i> , A new species of Eulimidae (Gastropoda, Prosobranchia) Parasitic on a Crinoid from Brazil	223
J. HELLER and S. EHRLICH—A Freshwater Prosobranch, <i>Melanoides tuberculata</i> , in a Hydrogen Sulphide Stream	237
P. TATTERSFIELD—A new species of <i>Truncatellina</i> (Gastropoda: Vertiginidae) from Mount Kenya and new distributional records of <i>Truncatellina ninagongonis</i> (Pilsbry) from East Africa	243
D. MINCHIN, D. McGRATH and C. B. DUGGAN—The Slipper Limpet, <i>Crepidula fornicata</i> (L.), in Irish Waters, with a Review of its Occurrence in the North-Eastern Atlantic	249
C. M. CAUDWELL, A. M. JONES and I. J. KILLEEN—Three Solenogastres from the Irish Sea, New to the British Marine Area	257
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE	271
H. M. ROE and R. C. PREECE—A New Discovery of the Middle Pleistocene ‘Rhenish’ fauna in Essex	272
B. VERDCOURT— <i>Maizania kazibae</i> Adam (Gastropoda, Prosobranchia, Maizaniidae) in Uganda	273
BOOK REVIEWS	275

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**NOTICE**

**Payment by Overseas Members**

Overseas members are reminded that all monies due to the Society are payable in sterling.

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# ECOLOGICAL FACTORS AFFECTING THE DISTRIBUTION OF THE GASTROPODS *AEGOPINELLA NITIDULA* (DRAPARNAUD, 1805) AND *NESOVITREA HAMMONIS* (STRÖM, 1765) IN NORTHWEST SPAIN

J. HERMIDA<sup>1</sup>, P. ONDINA<sup>1</sup> AND A. OUTEIRO<sup>1</sup>

(Accepted for publication, 22nd April, 1995)

**Abstract:** *Aegopinella nitidula* and *Nesovitrea hammonis* are land snails whose broad-scale distributions are similar but which often occur in different habitats. We investigated possible relationships between environmental factors – biotope type (woodland, river-bank or meadow) and 20 edaphic factors – and the distributions of these two species in northwest Spain. Frequency of occurrence of *Aegopinella nitidula* was significantly higher than expected in sites with low to intermediate soil Mg content, low soil pH and intermediate soil Al content. Frequency of occurrence of *Nesovitrea hammonis* was significantly higher than expected in meadow sites and in sites with high soil moisture content, high soil porosity, a low soil C:N ratio of 0–10, and high soil N content.

**Key words:** Ecology, Gastropods, *Aegopinella nitidula*, *Nesovitrea hammonis*, Iberian Peninsula.

## INTRODUCTION

*Aegopinella nitidula* and *Nesovitrea hammonis* are closely related land snails in the family Zonitidae. In many parts of Europe, the two species have similar broad-scale distributions but tend to occur in different habitats, which has led a number of authors (most notably Mordan, 1977) to investigate the possible effects of environmental factors on the distribution and abundance of the two taxa. Mordan (1977) suggested that the differences in their distributions are at least partially explained by differences in soil moisture regime, *N. hammonis* being more tolerant of desiccation.

Recent studies have also suggested that these differences may be partially explained by differences in soil chemistry, such as pH values, calcium, potassium, magnesium, aluminium or nitrogen (Atkins & Lebour, 1923; Burch, 1955; Cameron, 1973; Outeiro *et al.*, 1989; Hermida *et al.*, 1995). More generally, soil texture characteristics have been reported to be important factors affecting the distribution of terrestrial gastropods (Kühnelt, 1957; Peake, 1978).

Different numerical methods may be used to study the relationships between gastropod distribution and environmental factors. The ecological profiles, described by Daget & Godron (1982), are used as an auto-ecological method. This technique has been used by André (1975), Outeiro, Ondina, Rodríguez & Castillejo (1989) and Outeiro, Agüera & Parejo (1993) in malacological studies.

On the basis of sampling carried out at 177 sites in northwest Spain, we investigated possible relationships between environmental characteristics – biotope type (woodland,

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river-bank or meadow) and 20 edaphic factors, including textural factors – and the distributions of these two species, using ecological profiles.

### MATERIALS AND METHODS

Sampling was carried out in different areas of northwest Spain (Asturias, León, Zamora and Salamanca provinces; Fig. 1). In each area, samples were collected from three biotope types (woodland, meadow and river-bank) by wet-sieving of litter and the top 5-cm layer of soil from an area of 0.5 m<sup>2</sup>, following the methods of Williamson (1959). For each of the 177 sampling sites the following edaphic factors were determined: % soil moisture, % porosity, % aeration, % gravel, % coarse sand, % fine sand, % coarse silt, % fine silt, % clay, % carbon, % nitrogen, carbon/nitrogen ratio, sodium (meq/100 g), potassium (meq/100 g), calcium (meq/100 g), magnesium (meq/100 g), aluminium (meq/100 g), soil pH in water, soil pH in KCl and litter pH in water. All determinations were carried out by the methods of Guitián and Carballas (1976).

We then used ecological profiles technique for the purpose of studying the behaviour of each species as compared to each factor measured, with its variation interval divided into classes. Class intervals were determined in terms of inflection points in the curve of accumulated frequencies (Daget and Godron, 1982). Species preference by class was obtained using corrected frequency profiles. For each edaphic variable, and for the three-category variable biotope type, we then used chi-square analysis to estimate the probability

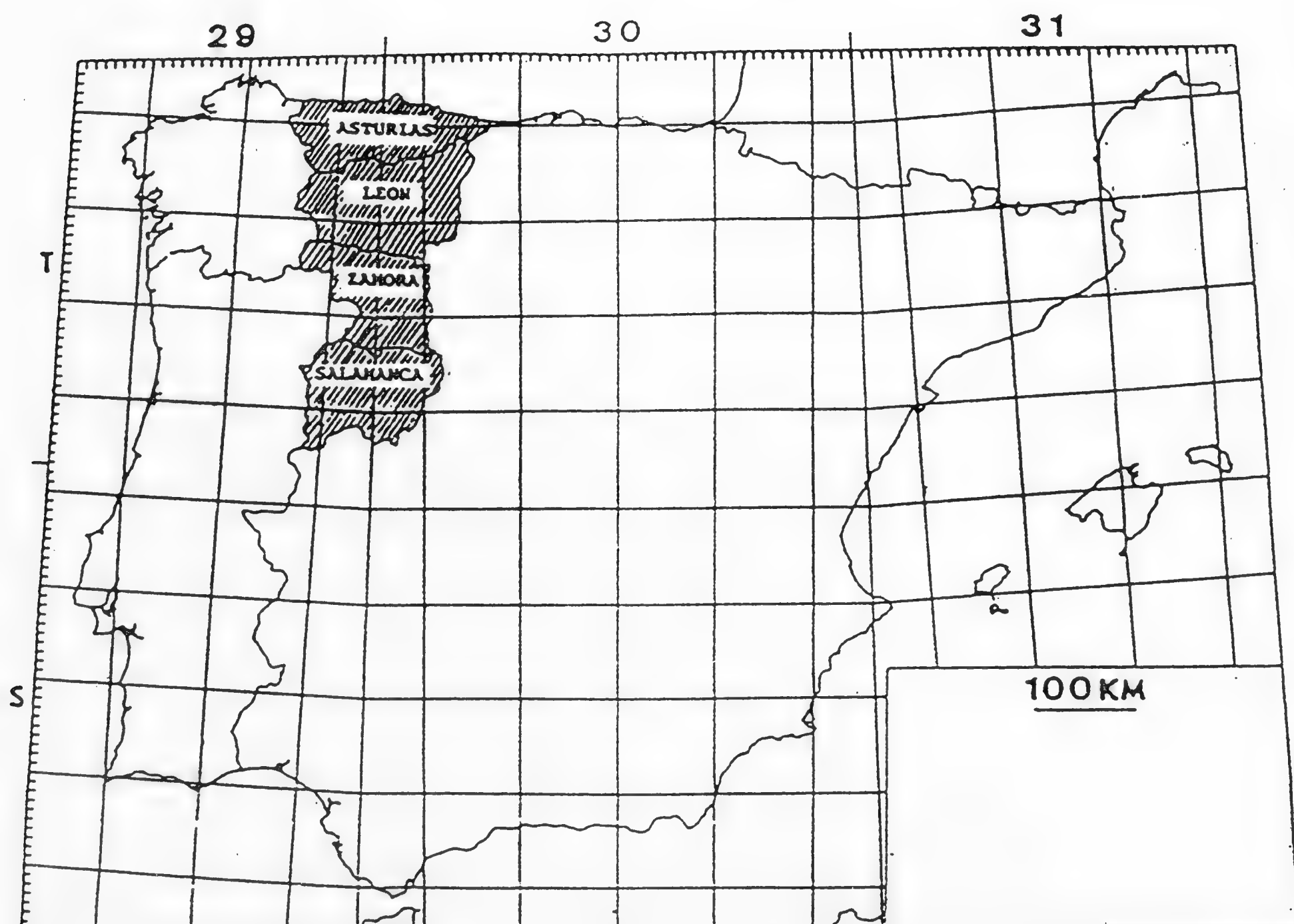


Fig. 1. Map showing the location of the study region (shaded) in the Iberian Peninsula.



that the observed frequencies of occurrence of each species in each class might have arisen given a uniform distribution with respect to that variable (Greig-Smith, 1957). A probability of less than 0.05 was taken to indicate a statistically significant correlation of that variable on the probability of occurrence of that species.

RESULTS

*Aegopinella nitidula* was present at 27, and *Nesovitrea hammonis* at 24, of the 177 sites (Appendix 1). Only three sites contained both *A. nitidula* and *N. hammonis*. A total of 85 individuals of *A. nitidula*, and 271 of *N. hammonis*, were recorded. For each of the three biotopes studied, percentage frequency of occurrence of each species, and mean number of individuals per m<sup>2</sup> where that species were present, are listed in Table I.

*A. nitidula* was most frequently recorded from woodlands (which, in the study area, are generally dominated by chestnut and oak) and river-banks; however, the observed frequency distribution with respect to biotope type did not differ significantly from a uniform distribution. *N. hammonis* was most frequently recorded from natural meadows dominated by *Gramineae* and *Papillonaceae*. The observed frequency distribution with respect to biotope type differs significantly from the uniform distribution ( $p<0.05$ ). Examination of the data (Table I) suggests that this significant result is probably due to low frequency of occurrence in woodland sites.

As regards edaphic factors, the class intervals for each factor that showed significant results are given in Table II. Five classes were established for moisture, porosity, magnesium, C/N ratio, nitrogen and pH in water, and three classes for aluminium.

Chi-squared analysis indicated that the probability of occurrence of *A. nitidula* has a significant positive correlation with soil Mg content ( $X^2 = 10.7$ ;  $p<0.05$ ), soil Al content ( $X^2 = 6.7$ ;  $p<0.05$ ) and soil pH ( $X^2 = 11.2$ ;  $p<0.05$ ). Soil textural factors showed no significant relationship. Visual inspection of the corrected frequency histograms for the factors with significant relationships (Fig. 2) suggests that this species occurs with higher than expected frequency at sites with intermediate Al content (0.1–1.0 meq/100 g) and at sites with low soil pH (4.9–5.5); the frequency distribution with respect to Mg is less clear, with relatively high

TABLE I

Percentage frequency of occurrence (FO%), number of sites and mean number per m<sup>2</sup>, where *A. nitidula* and *N. hammonis* were present (SD = standard deviation)

<i>Aegopinella nitidula</i>			
	FO%	Number of sites at which <i>A. nitidula</i> was present	Mean number per m <sup>2</sup> where <i>A. nitidula</i> was present, ± SD
Woodland	18.6	11	6.4±7.4
Meadow	10.2	6	3.3±2.4
River bank	16.9	10	8.0±4.8
<i>Nesovitrea hammonis</i>			
	FO%	Number of sites at which <i>N. hammonis</i> was present	Mean number per m <sup>2</sup> where <i>N. hammonis</i> was present, ± SD
Woodland	3.4	2	5.0±1.4
Meadow	22.0	13	26.1±27.7
River bank	15.2	9	22.4±34.8

TABLE II

Class codes, range of each class and number (N) of samples in each class, for the factors that showed significant results

	Code	Range	N		Code	Range	N
Moisture	1	6.0–19.5	39	C/N ratio	1	0.0–10.0	35
	2	19.6–27.0	40		2	10.1–11.0	41
	3	27.1–33.5	42		3	11.1–11.7	37
	4	33.6–42.9	32		4	11.8–13.7	35
	5	42.9–80.0	24		5	13.8–25.0	29
Porosity	1	37.0–55.9	22	Nitrogen	1	0.0–0.1	33
	2	56.0–67.0	44		2	0.1–0.2	43
	3	67.1–72.5	34		3	0.2–0.3	38
	4	72.6–81.0	45		4	0.4–0.5	38
	5	81.1–97.0	32		5	0.5–1.4	25
Magnesium	1	0.0–0.7	28	pH in water	1	3.0–4.8	31
	2	0.8–1.5	37		2	4.9–5.5	39
	3	1.6–2.5	45		3	5.6–6.5	39
	4	2.6–5.5	44		4	6.6–7.5	37
	5	5.6–20.0	23		5	7.6–9.0	31
Aluminium	1	0.0–0.0	124				
	2	0.1–1.0	32				
	3	1.1–12.0	21				

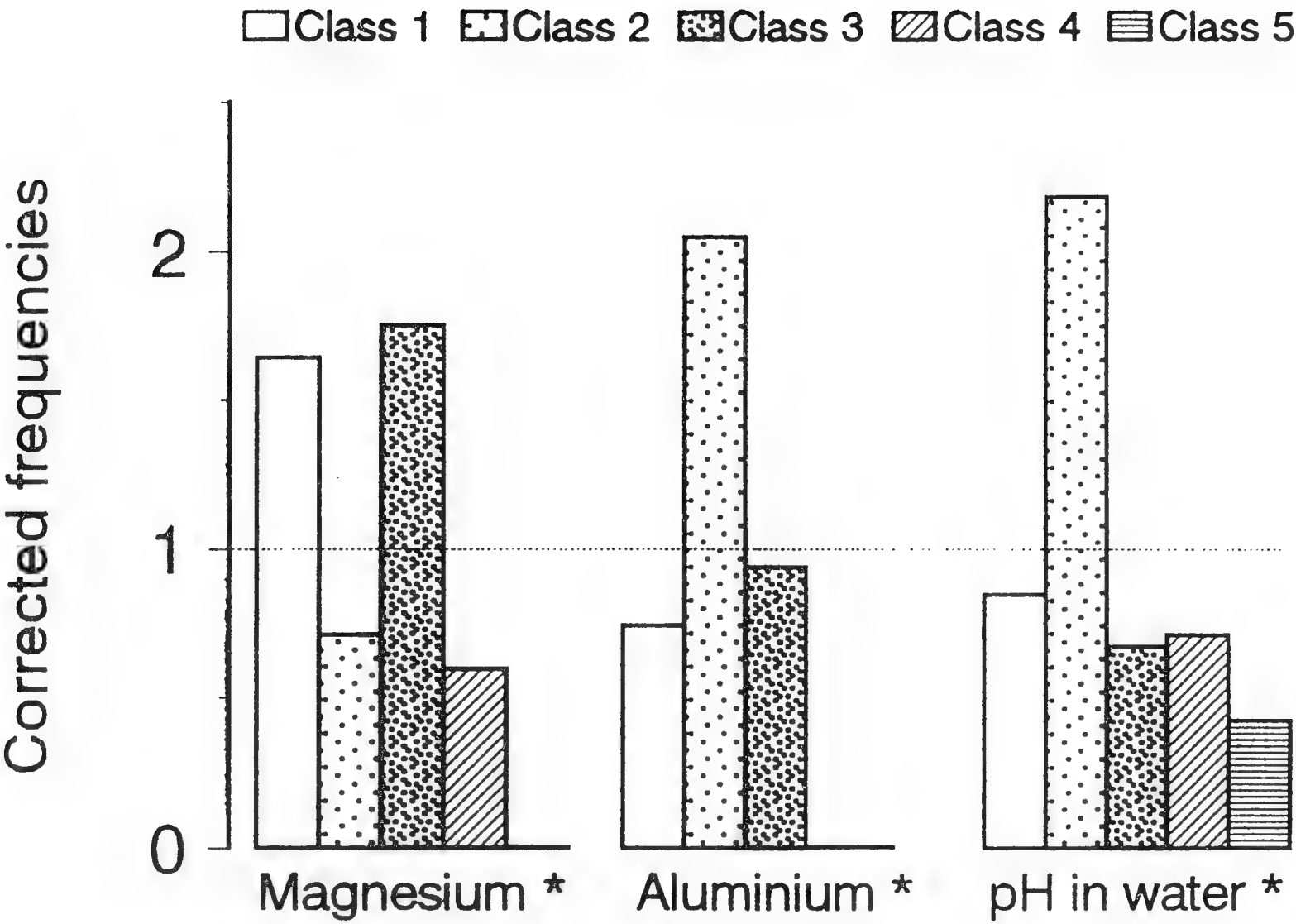


Fig. 2. Corrected frequency histograms for those factors which had a statistically significant correlation on the probability of occurrence of *Aegopinella nitidula*. Corrected frequency is given by  $F_c/F_t$ , where  $F_c$  is the relative frequency of occurrence of *A. nitidula* in samples of factor class  $c$ , and  $F_t$  is the relative frequency of occurrence of *A. nitidula* in all samples. The degree of preference is shown by values greater than 1.

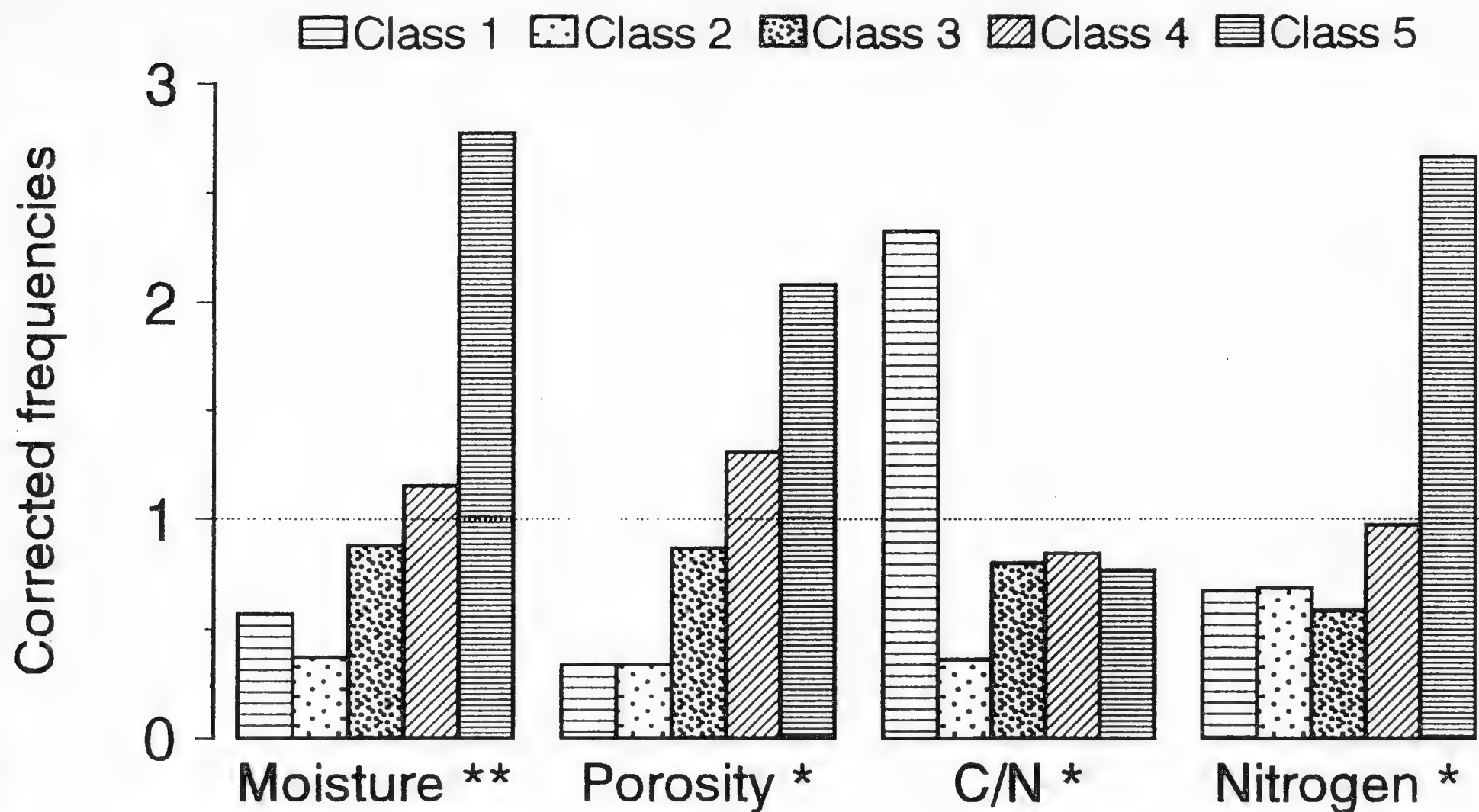


Fig. 3. Corrected frequency histograms for those factors which had a statistically significant correlation on the probability of occurrence of *Nesovitrea hammonis*. Corrected frequency is given by  $F_c/F_t$ , where  $F_c$  is the relative frequency of occurrence of *N. hammonis* in samples of factor class  $c$ , and  $F_t$  is the relative frequency of occurrence of *N. hammonis* in all samples. The degree of preference is shown by values greater than 1.

frequencies in the 0.0–0.7 and 1.6–2.5 meq/100 g classes but not in the 0.8–1.5 meq/100 g class.

With regard to the relation of *N. hammonis* with edaphic factors, chi-squared analysis indicated that the probability of occurrence of *N. hammonis* has a significant positive correlation with soil moisture ( $X^2 = 13.5$ ;  $p < 0.001$ ), soil porosity ( $X^2 = 9.6$ ;  $p < 0.05$ ), soil C:N ratio ( $X^2 = 11.1$ ;  $p < 0.05$ ) and soil N content ( $X^2 = 11.2$ ;  $p < 0.05$ ). As with *A. nitidula*, soil textural factors showed no significant relationship. Visual inspection of the corrected frequency histograms for the factors with significant correlations (Fig. 3) suggests that this species occurs with higher than expected frequency at sites with high soil moisture content (33.6–80.0%), sites with high porosity (72.6–97.0%), sites with low C/N ratio (0.0–10.0) and sites with high N content (0.5–1.4%).

## DISCUSSION

Direct comparison of our results with those of related previous studies is difficult, partly because the two species studied here occur in a wide range of community types, and partly because a number of relevant edaphic factors (particularly texture factors) have received very little attention to date. We investigated possible relationships between environmental factors and the distribution of *A. nitidula* and *N. hammonis*. Despite reports that soil textural factors may be important determinants of terrestrial gastropod distributions (Peake, 1978; Kühnelt, 1957), our results do not indicate a significant correlation of such factors on the distribution of either species.

In the Iberian Peninsula, the two species are similarly distributed over most of the northern part. However, they appear to have somewhat different habitat preferences, which may reflect edaphic requirements. The fact that *A. nitidula* is a reported predator of *N.*



*hammonis* (Mordan, 1977), could result in these two species appearing in different habitats; however a chi-squared test on the expected and observed co-occurrence of the two snail species did not show a significant negative correlation between them.

*A. nitidula* is generally considered to be a woodland species which is common in wet locations including river-banks (Ellis, 1969; Bishop, 1977; Mordan, 1977; Solh y, 1981; W reborn, 1982; Marquet, 1983; Riballo et al., 1985; Outeiro, 1988). Most authors have reported *N. hammonis* to be more common in meadows (Adam, 1960; Mordan, 1977; Riballo, 1990). We found *N. hammonis* with lower than expected frequency in woodland, confirming this difference between the two species.

*A. nitidula* was found most frequently in soils with low pH. Bishop (1977) similarly reported this species to be most frequent in acid soils (pH 4.8–5.0). Other authors, however, have reported it from neutral and even alkaline soils (Atkins & Lebour, 1923; Cameron, 1973), or have found pH to have no significant correlation on either frequency of occurrence or abundance (Fog, 1979). The preference of *A. nitidula* for different pH values suggest that the pH is not decisive in the distribution of this species, and probably other factors (such as edaphic, climatic and geological factors), or the interaction among them, being most important.

Our finding that the distribution of *A. nitidula* is correlated with soil Al and Mg contents, at least in the northwest Iberian Peninsula, confirms the findings of Riballo (1990).

We found *N. hammonis* to be most frequent in sites with high soil moisture content. Mordan (1977), who studied three species of the family Zonitidae (*A. nitidula*, *N. hammonis* and *Aegopinella pura*), reported *N. hammonis* to be the most tolerant of dehydration. Our results agree with this author, because although we have found this species in the wet meadows, these were always drier than the woodland where *A. nitidula* was found. For this reason, and comparing the two species, it can be said that *N. hammonis* is more tolerant to desiccation than *A. nitidula*.

Our finding that the distribution of *N. hammonis* is related to soil porosity, C/N ratio and N content, again confirms the results of Riballo (1990), although this author found frequency of occurrence to be highest in soils with low to intermediate (as opposed to high) N content. Riballo (1990) found *N. hammonis* to be most frequent in soils with 0.0 to 0.7% nitrogen, whereas we found the preferred range to be 0.46 to 1.40%. This apparent discrepancy may indicate that C/N ratio is in fact the significant factor, rather than the nitrogen. Our results indicate that *N. hammonis* prefers mull soils (which have a low C/N ratio); such soils typically have well-developed humus and are rich in hydrosoluble organic compounds which are readily assimilated by soil detritivores. *N. hammonis*, as well as others small species of the Family Zonitidae M rch, 1864, feed on rotting vegetation (Haas, 1991), generally occupying the surface layers of the soil, and may be forced to take refuge in deeper layers in the event of prolonged subzero temperatures or drought: the availability of readily assimilable organic compounds in the soil may thus be an important factors governing the distribution of this species. In the case of predominantly herbivorous macrogastropods such as *Helix aspersa* (O. F. M ller, 1774), *Cepaea nemoralis* (Linn , 1758) or *Arion ater* (Linn , 1758), which do not live in the soil itself, these factors are unlikely to be so important.

We did not find any significant correlation of the soil textural characteristics on the distributions of either species. However K hnelt (1957) suggest that there is a relationship between species size and the texture of the soil on which they live. According to this author, in areas having fine textured soil, such as meadows, smaller sized species occur.

In conclusion, our results confirm previous reports that *A. nitidula* occurs more frequently than *N. hammonis* in woodland, and less frequently than *N. hammonis* in more open habitats. We found *N. hammonis* in drier sites than *A. nitidula*, suggesting that *A. nitidula* is less desiccation-tolerant than *N. hammonis*. Furthermore, our results broadly coincide with those of Riballo (1990), and suggest that the distributions of *A. nitidula* and *N. hammonis*, at least in

northwest Spain, are correlated with chemical characteristics of the soil; but we did not find any significant relationship with soil texture.

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## APPENDIX 1.

Sites (and provinces), sampling date, UTM 10 × 10 Km co-ordinates and biotope, for *A. nitidula* and *N. hammonis*.

*Sites where A. nitidula was present.*

1. Arangas (Asturias), 11/06/1987, 30TUP50. Meadow.
2. Arangas (Asturias), 11/06/1987, 30TUP50. Woodland (chestnut tree).
3. Arenas de Cabrales (Asturias), 11/06/1987, 30TUN59. Woodland (walnut tree and cherry tree).

4. Pola de Allande (Asturias), 13/12/1988, 29TPH99. River bank.
5. Alto de Labadoira (Asturias), 13/12/1988, 29TPH99. River bank.
6. San Román (Asturias), 17/03/1988, 30TUN29. River bank.
7. Sellaño (Asturias), 17/03/1988, 30TUN29. Woodland (chestnut tree).
8. La Morca (Asturias), 20/06/1988, 30TUP20. Meadow.
9. Llordón-El Llano (Asturias), 20/06/1988, 30TUP20. Meadow.
10. Covadonga (Asturias), 11/12/1988, 30TUN39. River bank.
11. Luarca (Asturias), 80/12/1987, 29TPJ92. Meadow.
12. La Bañeza (León), 22/06/1988, 29TQG28. Meadow.
13. La Bañeza (León), 22/06/1988, 29TQG28. Woodland (oak tree).
14. Candanedo (León), 10/12/1987, 30TTN94. River bank.
15. Candanedo (León), 10/12/1987, 30TTN94. Woodland (black poplar).
16. Vierdes (León), 19/06/1988, 30TUN37. River bank.
17. La Puerta (León), 09/06/1987, 30TUN36. Meadow.
18. Villablino (León), 14/12/1988, 29TQH25. Woodland (oak tree).
19. Villafranca de Bierzo (León), 23/06/1988, 29TPH72. Woodland (chestnut tree).
20. Friera (León), 23/06/1988, 29TPH71. Woodland (holm oak and cherry tree).
21. Alcañices (Zamora), 07/12/1988, 29TQG03. River bank.
22. Moncabril (Zamora), 13/06/1988, 29TPG86. Woodland (oak tree).
23. Trefacio (Zamora), 13/06/1988, 29TPG96. Woodland (ash tree and oak tree).
24. Alto de Los Quemados-Candelario (Salamanca), 04/03/1987, 30TTK67. River bank.
25. Alto de Los Quemados-Candelario (Salamanca), 04/03/1987, 30TTK67. Woodland (oak tree).
26. Bejar (Salamanca), 04/03/1987, 30TTK77. River bank.
27. La Alberca (Salamanca), 14/12/1987, 29TQE48. River bank.

*Sites where N. hammonis was present.*

1. Pola de Allande (Asturias), 13/12/1988, 29TPH99. Meadow.
2. Pola de Allande (Asturias), 13/12/1988, 29TPH99. River bank.
3. Alto de Labadoira (Asturias), 13/12/1988, 29TPH99. Meadow.
4. San Román (Asturias), 17/03/1988, 30TUN29. Meadow.
5. La Morca (Asturias), 20/06/1988, 30TUP20. Meadow.
6. Llordón-El Llano (Asturias), 20/06/1988, 30TUP20. River bank.
7. Luarca (Asturias), 08/12/1987, 29TPJ92. Meadow.
8. Luarca (Asturias), 08/12/1987, 29TPJ92. River bank.
9. Piñera (Asturias), 09/12/1987, 29TPJ82. Meadow.
10. Piñera (Asturias), 09/12/1987, 29TPJ82. River bank.
11. Piñera (Asturias), 09/12/1987, 29TPJ82. Woodland (chestnut tree, oak tree and pine tree).
12. Alto de la Madera (Asturias), 29/02/1987, 30TTP81. Meadow.
13. Tarna (Asturias), 17/06/1988, 30TUN17. Meadow.
14. Tarna (Asturias), 17/06/1988, 30TUN17. River bank.
15. La Bañeza (León), 22/06/1988, 29TQG28. Meadow.
16. La Bañeza (León), 22/06/1988, 29TQG28. River bank.
17. La Puerta (Asturias), 09/06/1987, 30TUN36. River bank.
18. La Puera (Asturias), 09/06/1987, 30TUN36. Woodland (black poplar).
19. Burón (Asturias), 09/06/1987, 30TUN36. Meadow.
20. Villablino (León), 14/12/1988, 29TQH25. Meadow.
21. Val de Santa María (Zamora), 02/03/1987, 29TQG35. Meadow.
22. Moncabril (Zamora), 13/06/1988, 29TPG86. Meadow.
23. Moncabril (Zamora), 13/06/1988, 29TPG86. River bank.
24. Toro (Zamora), 13/03/1988, 30TTL98. River bank.



# THE GENUS *CRASSISPIRA* (GASTROPODA, TURRIDAE) IN WEST AFRICA

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(Accepted for publication, 22nd April, 1995)

**Abstract:** The species of the genus *Crassipira* of West Africa were studied mainly on the basis of the characteristics of the shell and the radular tooth. Ten species are studied, five of these are new and one is doubtful. A neotype for *C. callosa* is designated, and also the type localities for *C. consociata* and *C. carbonaria* are defined.

**Resumen:** Se estudian las especies oesteafricanas del género *Crassipira* principalmente en base a las características de la concha y del diente radular. De un total de 10 especies estudiadas, 5 son descritas como nuevas, y otra más es dudosa. Se designa un neotipo para *C. callosa* y también se definen las localidades típicas para *C. consociata* y *C. carbonaria*.

**Key words:** Turridae, *Crassipira*, West Africa, new species.

## INTRODUCTION

The family Turridae in West Africa is very numerous in species, 45 taxa of Turridae (*sensu lato*) are mentioned in Dautzenberg (1913) and 49 in Knudsen (1956). The authors have found 147 taxa in the literature referred to West African coasts.

Few recent papers have been published on West African Turridae: Gofas (1991), described a new species, Rolán & Fernandes (1993), reported on species from São Tomé and Príncipe and Rolán, Otero-Schmitt & Fernandes (1994), revised the genus *Bactrocythara*. Although many species of Turridae have been mentioned in general books (Nicklés, 1950; Bernard, 1984; Gofas, Pinto Afonso & Brandão, 1985), no revision exists for this group in West Africa.

Taylor, Kantor & Sysoev (1993) studied the anatomy of selected species from different genera and established a new classification in the superfamily Conoidea, on the basis of the foregut structures and feeding mechanisms. In this revision, the genus *Crassipira* Swainson, 1840 is placed in the Turridae within the subfamily Crassispirinae Morrison, 1966. This subfamily has claviform to fusiform shells, a short anterior canal a well developed parietal callus; a radula with robust wishbone type marginal teeth and vestigial lateral teeth; a proboscis with anterior buccal tube sphincter and a medium to small odontophore with fused cartilages.

Powell (1966) stated that the genus *Crassipira* has many Recent species in West America and in the Caribbean, and to a limited extent in the Indo-Pacific. Fossil species are reported from the Tertiary of America, Europe and Indo-Pacific. Powell (1966) gave the opinion that the genus name *Crassipira* has been widely applied or misapplied in a worldwide coverage from the Eocene to the present because there is a tendency to include in *Crassipira* every species that exhibits a strong subsutural fold. This author did not mention any West African species.

There are two recent regional revisions of this genus: South Africa (Kilburn, 1994),

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Hong Kong and Southern China (Taylor & Wells, 1994). For West Africa only three species are reported by Nicklés (1950) and Bernard (1984), this being the same number mentioned for this area by Tryon (1884). This gives an idea of the limited data for this genus in West Africa which gave the impetus for the revision presented here.

### MATERIAL AND METHODS

Part of the material was obtained on several expeditions by the first two authors although most of it by the first author in Angola. Also material deposited in the MNHN and the MNCN was studied. Some additional material was sent by M. Pin and P. Ryall. Types of the previous known taxa were checked.

The study focused on the comparison of the shell size, sculpture and colour, as well as the periostracum and operculum, when they were available; the protoconch was only available in a few species, because most of them are decollated. The morphology of the radular teeth was studied employing the terminology of Powell (1966). In *Conus* Rolán (1992), established a relation between the length of the shell (LC) and the radular tooth size (DR). This ratio (LC/DR) was found to be different between species, although decollation can be a modifying factor of this ratio, and may be a good method of comparison.

The material examined refers to specimens, when this belongs to live collected animals; to shells if it lacks the animal.

### ABBREVIATIONS

AMNH	American Museum of Natural History, New York
BMNH	The Natural History Museum, London
CER	collection E. Rolán, Vigo
CFF	collection of Francisco Fernandes, Luanda
CMP	collection of Marcel Pin, Dakar
COS	collection of J. Otero-Schmitt, Santiago de Compostelo
CPR	collection of Peter Ryall, Takoradi
MNCN	Museo Nacional de Ciencias Naturales, Madrid
MNHN	Museum National d'Histoire Naturelle, Paris
NMW	National Museum of Wales, Cardiff
ZMA	Zoölogisch Museum, Amsterdam

### SYSTEMATICS

#### Genus *Crassispira* Swainson, 1840

Type species *Pleurotoma bottae* Kiener, 1839–40

This genus (Powell, 1966) has shells of moderate to large size, 15–50 mm, mostly dark brown or black, elongate-fusiform, more or less truncated anteriorly, with a broad flat subsutural fold, usually smooth, sometimes nodulous. There is a stout axial sculpture from the shoulder to over the base, sometimes with spiral cords. Sinus moderately deep, U-shaped, in the concavity between the subsutural margin and the shoulder angle. Operculum ovate, with a terminal nucleus. Radula, a pair of marginal teeth only, elongated, rather narrow and more

or less parallel sides, abruptly tapered to a sharp point; a narrow, much smaller accessory plate is superimposed on the lower part of the main tooth. This plate must be considered as a vestigial lateral tooth (Taylor *et al.*, 1993).

Kilburn (1988) compares this genus only with *Nquma* Kilburn, 1988, and regards it near to *Buchema* Corea, 1934. *Nquma* (type species *Pleurotoma rousi* Sowerby, 1886) has moderately small shells (12–20 mm), claviform in shape, with low spire (often decollated in adult), a papilliform apex and a relatively small aperture. It differs from *Crassispira* because the anal sinus is deeper and almost closed, and the colour pattern is drab, with spots and markings, instead of a uniform dark colour. *Buchema* (type species *Carinodrillia tainea* Corea, 1934) has small shells, being similar in the rest of the characteristics, and for this reason it still needs to be justified.

In our view, we found that the West African species are similar to the Recent American species usually included in the genus *Crassispira*, by their shell morphology, dark colour (most of them), operculum and radula, being different only because of their larger size and the usual decollation.

### ***Crassispira carbonaria* (Reeve, 1844)**

(Figs. 1, 2, 3, 4, 5, 29, 30)

*Pleurotoma carbonaria* Reeve, 1843: p. 187, pl. 17, fig. 145.

*Drillia carbonaria* (Reeve). Tryon (1884): pl. 13, fig. 68.

*Crassispira carbonaria* (Reeve). Nicklés (1950): p. 127, fig. 257.

*Turris carbonaria* (Reeve). Knudsen (1952): p. pl. 1, fig. 8)

*Type material*: 1 figured syntype, here designed as lectotype (Figs. 1 & 2): (Stainforth/Taylor) Melvill-Tomlin collection, NMW n° 1955.158.910.

*Type locality*: Unknown.

*Other material examined*: *Senegal*: 6 specimens and 10 shells, Gorée Bay, at 10–15 m (CMP); 2 specimens, N-Casamance, 12°46'N, 17°12'W, at 22 m (MNHN); 1 specimen, S-Casamance, Katakalous Bôlon, at 3–4 m (MNHN); 22 shells, Rifinesque Bay, at 10–20 m (MNHN); 1 juvenile shell, Popenguine, at 35 m (MNHN); 3 shells from Jousseau collection (MNHN); 6 specimens, Cap Manuel, Dakar, at 18 m (MNHN); 2 shells, Port de Dakar, Mauny, collection (MNHN).

*Ivory Coast*: 1 specimen, 4°40'N, 2°08'W, Calypso 1956, at 50 m, (MNHN).

*Ghana*: 7 specimens and 25 shells, all juvenile, Miamia, at 20–25 m (CER).

*Guinean Gulf*: 1 shell, between Tamana I. and Cassa I., Calypso 1956, at 7–8 m, (MNHN).

*Cameroun*: 5 specimens, Victoria/Limbé – Bota, at 8–10 m (MNHN).

*Republic of São Tomé and Príncipe*: 4 specimens, Calypso 1956 (St. P7), at 6 m, (MNHN).

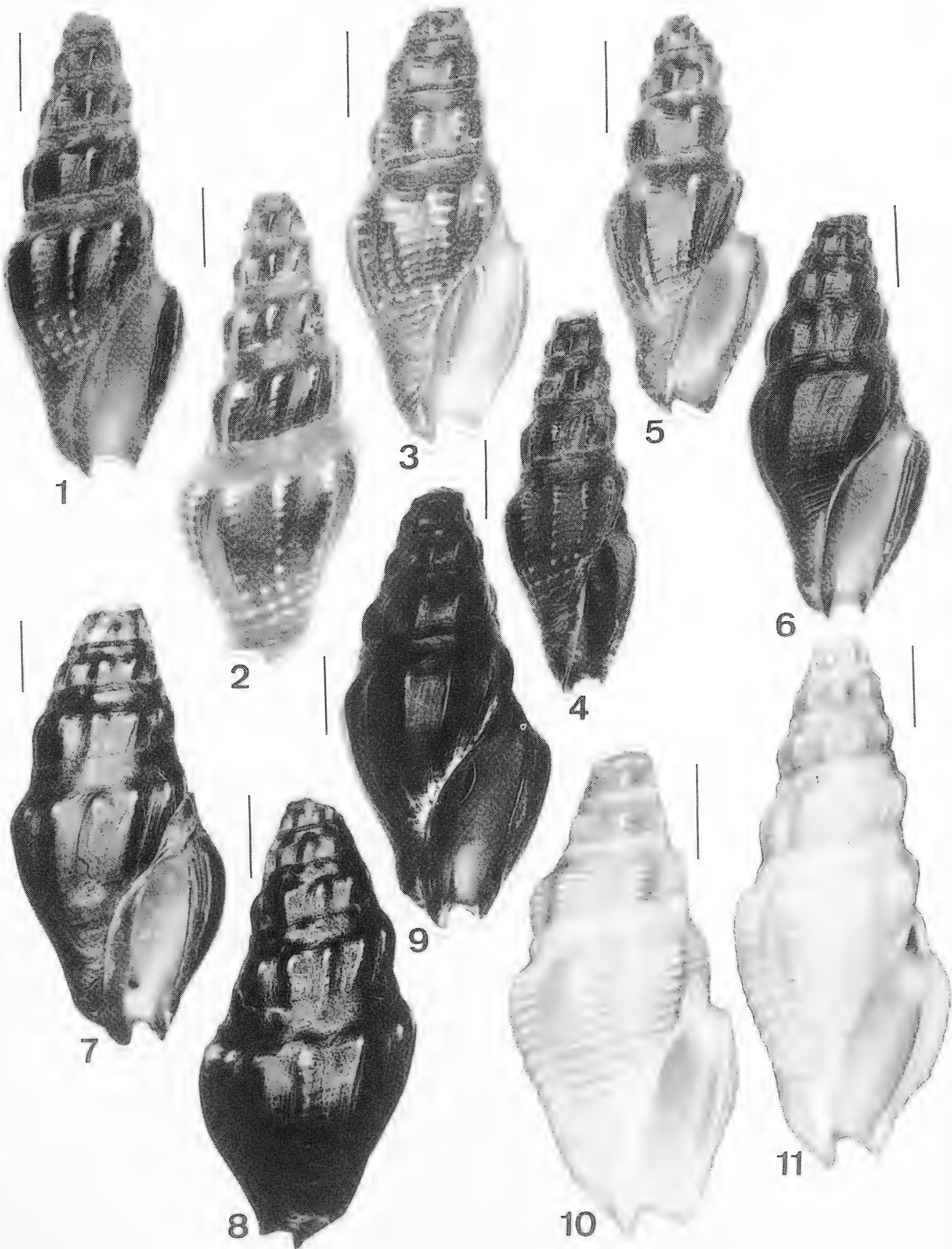
*Gabon*: 2 specimens, Port-Gentil, 0°55'S, 8°44,6'E, at –30 m (MNHN); 4 shells, Cap Esterias-pointe Idolo, low intertidal, (MNHN).

*Congo Republic*: 32 specimens, Pointe-Noire, Orstom Beach, at 5–7 m (MNHN); 8 specimens, Pointe-Noire, Plage Songolo, at 5–6 m (MNHN); 1 specimen, Pointe-Noire, Plage Mondaine, Club Nautique Vase, at 6 m (MNHN); 1 shell (Hattenberger coll.).

*Measurements*: Lectotype 30 mm in length; in our material few shells are larger than this size.

*Description*: Shell (Fig. 1, 2, 3, 4 & 5) solid, decollated, with 4–5 spiral whorls and 7–9 strong axial ribs on the body whorl, crossed by smaller spiral threads frequently nodulous on the ribs, specially at the base. Smooth subsutural depression limited below by the shoulder. Aperture elongate, with a quite broad siphonal canal. Colour dark brown to blackish, lighter on the ribs. Some specimens are lighter in colour, exceptionally creamish.





Protoconch: 1 specimen, 7 mm in length, from Senegal has a nearly complete protoconch, with more than 3 smooth spiral whorls.

Operculum brown, pyriform elongated, with a terminal nucleus.

Radula (Fig. 29) composed of two rows of marginal teeth, between 30 and 40 pairs. Tooth (Fig. 30) lanceolate, broader in the upper third, where it has an angulation with a prominent rounded part where a barb is present on other species; from this point, the tooth becomes narrower and is in contact with a smaller, curved and grooved accessory plate – regarded as the vestigial lateral tooth by Taylor et al. (1993) –, which is adhered to the tooth. In the five specimens studied, the ratio between the length of the shell (LC) and the size of the radular tooth (DR), LC/DR was about 112.

*Habitat*: Sandy and muddy bottoms, from 5 m to 30 m depth.

*Geographic range*: Senegal to Zaire.

*Remarks*: The original description does not mention any locality. The shells are quite variable but those from Ghana are most similar to the lectotype (see Fig. 1 and 4), therefore, we believe that it should be regarded the type locality.

The shell represented with this name in Gofas *et al.* (1985), p. 88, fig. j) is not this species but one of those described below.

***Crassispira funebris* n. sp.**  
(Figs. 6, 7, 8, 9, 31)

*C. carbonaria* Reeve. Gofas *et al.* (1985): p. 88, fig. j.

*Type material*: Holotype (Figs. 7 & 8) 28.7 mm, ex. CFF, MNCN n° 15.05/18730. Single paratypes in AMNH, BMNH, CER and COS, 6 in CFF, all from Farol das Lagostas, Luanda, at 10 m (ex CFF); 7 specimens, Barra do Dande, prov. Bengo, infralittoral, (MNHN); 9 specimens, Barra do Dande, prov. Bengo, infralittoral, (MNHN); 9 specimens, Cacuaco, 0–1 m, (MNHN).

*Type locality*: Farol das Lagostas, Luanda, Angola.

*Other material examined*: *Congo Republic*: 5 specimens, Orstom Beach, Pointe-Noire, at 3–4 m, (MNHN).

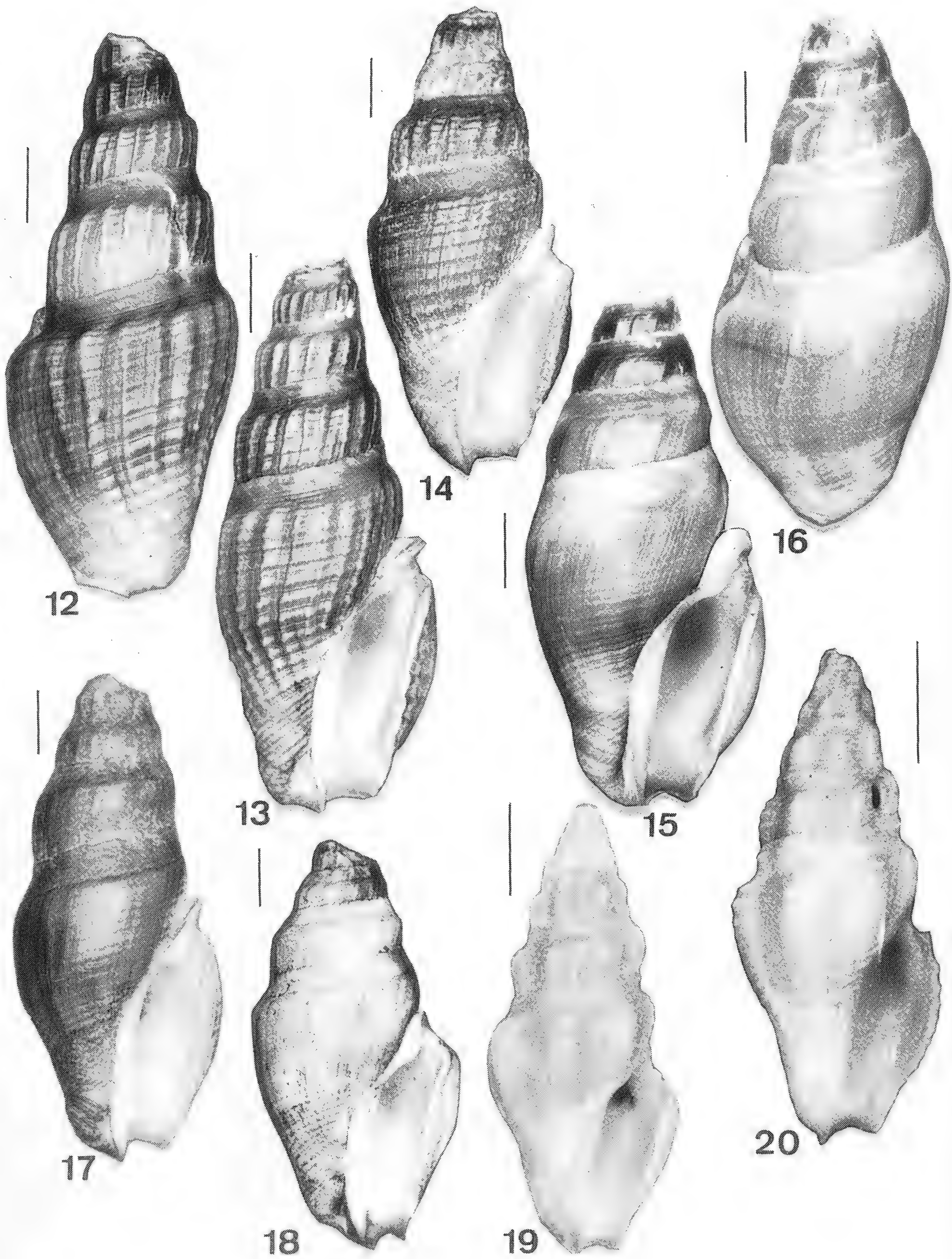
*Angola*: 2 specimens and 1 shell, Cacuaco, 0–1 m, (MNHN); 20 specimens, Cacuaco, infralittoral, (MNHN); 3 specimens, Cacuaco, 7 m (CER).

*Measurements*: To 32 mm in length.

*Description*: Shell (Figs. 6, 7, 8 & 9) solid, elongate ovoid in shape, clearly decollated, with 4–5 teleoconch whorls. Sculpture of about 11 oblique axial ribs on first whorl, increasing to 14–

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- Fig. 1. *Crassispira carbonaria*. Lectotype (NMW).  
 Fig. 2. *Crassispira carbonaria*. Lectotype (NMW).  
 Fig. 3. *Crassispira carbonaria*. Gorée, Senegal.  
 Fig. 4. *Crassispira carbonaria*. Miamia, Ghana.  
 Fig. 5. *Crassispira carbonaria*. Pointe-Noire, Congo Republic.  
 Fig. 6. *Crassispira funebris*. Pointe-Noire, Congo Republic.  
 Fig. 7. *Crassispira funebris*. Holotype (MNCN), Farol das Lagostas, Luanda, Angola.  
 Fig. 8. *Crassispira funebris*. Holotype (MNCN), Farol das Lagostas, Luanda, Angola.  
 Fig. 9. *Crassispira funebris*. Paratype (AMNH), Luanda, Angola.  
 Fig. 10. *Crassispira* sp. Gabon.  
 Fig. 11. *Crassispira* sp. Gorée, Senegal.  
 (scale bar 5 mm)







15 on the body whorl, with nodules on the shoulder, narrower than the intermediate spaces. The spiral sculpture is attenuated on most of the shells, being only evident on the base and sometimes on the shoulder. Suture evident, with a broad subsutural depressed margin. Aperture elongate oval, with a sharp outer lip, with an external last rib thicker than the previous. Stromboid notch small, close to siphonal canal, which is short, broad and incurved towards dorsum. Anal sinus U-shaped, the columellar lip having on its upper part a prominent enlargement. Colour deep black, even in the aperture, on the outer and columellar lips, blue-white in the inner part of the aperture; the nodules on the shoulder are lighter, sometimes whitish; exceptionally, on the lower part of the axial ribs there may be whitish nodules at the intersections.

Animal black in colour, except the sole of the foot which is cream.

Operculum corneus, strong, pyriform, without apparent nucleus.

Radula with 20–30 rows of marginal teeth, connected to each other by a membrane, and only free at apical portion. The tooth (Fig. 31) is lanceolate, without barb or angulation, and slightly curved. The smaller accessory plate is grooved, and usually protudes at the base. LC/DR = 125.

*Etymology*: The specific name is derived from funebral (funeral), alluding to its deep black colour.

*Habitat*: On rocky substrates, from low intertidal to 10 metres depth.

*Geographic range*: Known from the Congo Republic to Angola.

*Comparisons*: *C. funebris* n. sp. differs from *C. carbonaria* because it is more solid and broader, has a deep black colour, and a more attenuated spiral sculpture. *C. carbonaria* is dark brown, sometimes lighter, especially in the interspace between the axial ribs, and it frequently has a whitish colour on the nodules at the crossing points of the sculpture; also it is more elongated, with more prominent angulation below the suture and it has fewer axial ribs. Besides, its radular tooth has an evident rounded prominence in the angulation, while *C. funebris* lacks this prominence, being only slightly rounded. Both species have a different distribution area, but coexist at Pointe-Noire, Congo Republic.

***Crassispira* sp.**  
(Figs. 10, 11, 32)

*Crassispira carbonaria* (Reeve 1844). Bernard (1984): p. 100, pl. 52, fig. 190.

*Material examined*: Senegal: 1 shell, I. Gorée, at 15–25 m, (MNHN); 1 specimen, Biénbering, Casamance, 12°30.4'N, 17°16'W, at 21 m, (MNHN); 1 specimen, Dakar, at 50 m (MNHN).

Guinea Bissau: 1 shell, Illes Bissagos, between Soga and Rouban, Mission L. Gain (1913), (MNHN).

Guinea: 1 juvenile, Calypso (1956), 9°45'N, 14°05'W, at 18 m, (MNHN).

Fig. 12. *Crassispira callosa*. Senegal.

Fig. 13. *Crassispira callosa*. Senegal.

Fig. 14. *Crassispira callosa*. Neotype (NMHN). Dakar, Senegal.

Fig. 15. *Crassispira oliva*. Holotype (MNCN). Farol das Lagostas, Luanda, Angola.

Fig. 16. *Crassispira oliva*. Holotype (MNCN). Farol das Lagostas, Luanda, Angola.

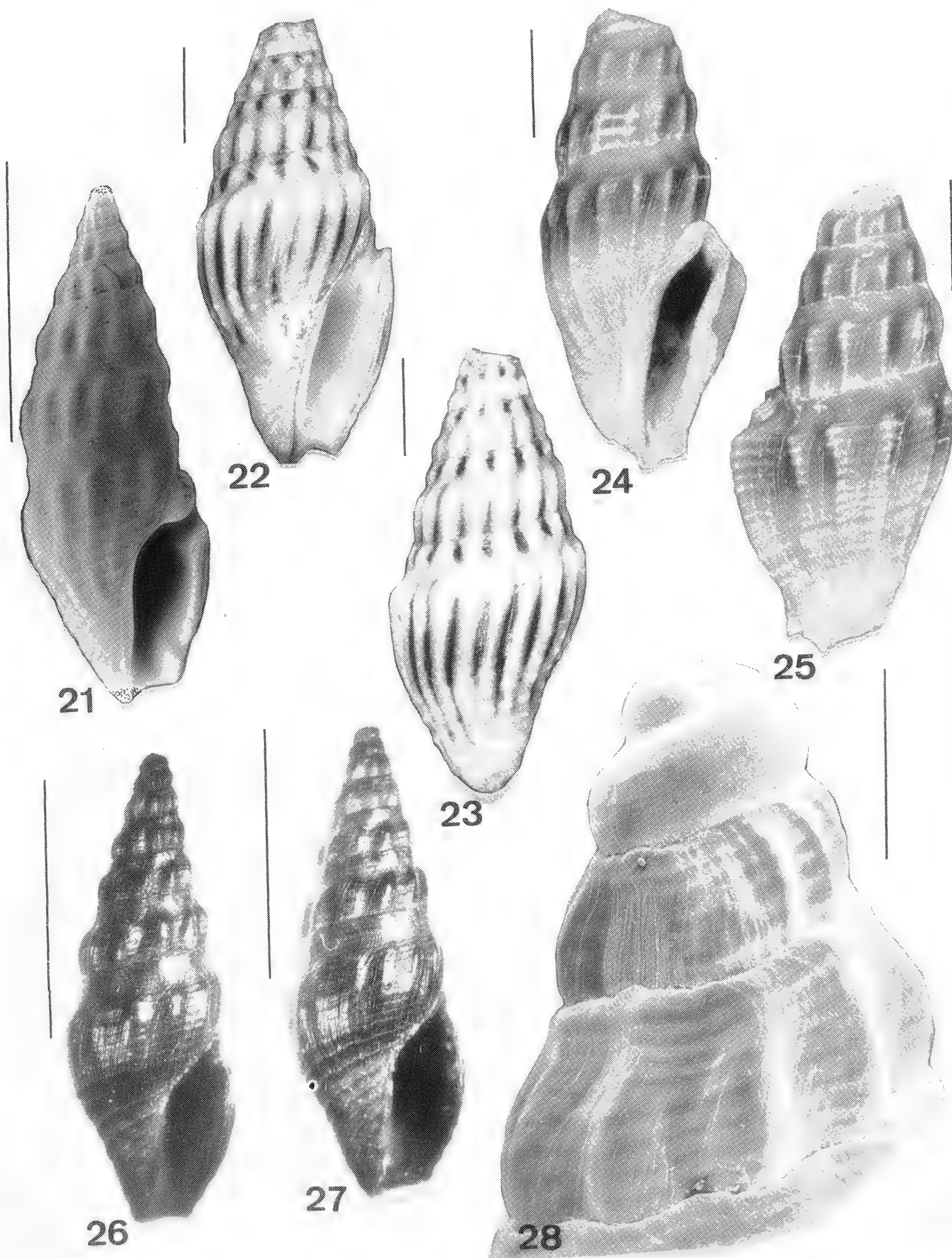
Fig. 17. *Crassispira oliva*. Congo Republic (MNHN). With periostracum.

Fig. 18. *Crassispira oliva*. Congo Republic (MNHN). Without periostracum.

Fig. 19. *Crassispira consociata*. Congo Republic (MNHN).

Fig. 20. *Crassispira consociata*. Holotype (BMNH).

(scale bare 5 mm)





*Cameroun*: 1 shell, Calypso (1956), at 45 m, (MNHN).

*Gabon*: 3 shells, Trois Rivières, Port-Gentil, at 5 m, (MNHN); 2 specimens, Port-Gentil, at 30 m, (MNHN); 3 specimens, Cocobeach, Port-Gentil, at 1–50 m, (MNHN).

*Republic of São Tomé and Príncipe*: 1 specimen, Calypso (1956), (MNHN).

*Measurements*: To 35 mm in length.

*Description*: Shell (Fig. 10 & 11) solid, decollated, with 4–5 spiral whorls. There are 6–7 broad, strong axial ribs on each whorl, interrupted between the suture and shoulder. Crossed by spiral threads which are on the axial protuberances and also in the interspaces, 4–5 in the first whorls, around 12 in the body whorl, and 8 more, very small and close to the base. Suture undulant, close to the previous whorl, with a spiral thread over the subsutural band. Aperture elongate, with its outer edge free and serrated. Inner lip free at the base. There is a stromboid notch close to the siphonal canal. Siphonal canal quite broad, slightly incurved. Anal sinus deep, U-shaped, a little narrower with a strong columellar nodule. Colour greyish-green, with clearer zones at the base, and a yellowish-white subsutural band; inner aperture bluish; shoulder lighter in some specimens. The spiral threads are clearer and whitish.

Radula tooth (Fig. 32) wider in the upper third, with an angulation and a rounded prominence. The ratio LC/DR is about 100 for the Gabon specimens; the Senegal specimens, more elongated, have a very different ratio, of about 170.

*Habitat*: Sandy bottom, between 5–50 m depth.

*Geographical range*: Known from Senegal to Gabon.

*Comparisons*: This is the species illustrated by Bernard (1984, fig. 190) as *C. carbonaria* and probably by Nickles (1950, fig. 257). In several collections, this species was also labelled as *C. carbonaria*. The shell has a greyish-green colour different from the dark or light brown of the true *C. carbonaria*. Also, the axial ribs are broader in *C. sp.* and its spiral threads are more numerous and continue on the ribs, without any nodule at the crossing-points. The radular tooth is similar to that of *C. carbonaria*, although the angulation and rounded prominence seem more evident in *C. sp.*

*Remarks*: We include in this group the specimens found in Senegal (Fig. 11), which are more elongated, and those from Gabon (Fig. 10), which are shorter; furthermore, their radulae seem to have a different ratio, being LC/DR about 100 in specimens from Gabon and 170 in those from Senegal. The specimens from Senegal (Fig. 11) may be more similar to the larger shells of *C. carbonaria* and those from Gabon (Fig. 10) to *C. consociata*. Therefore, the shells included in this group could be an undescribed species or two different ecological forms of other *Crassispira*. To define this situation, more material and information on the sympatric areas with other species will be needed.

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- Fig. 21. *Crassispira sacerdotalis*. Holotype (MNCN). São Tomé. SEM photograph.  
 Fig. 22. *Crassispira bernardi*. Holotype (MNCN). Cacuaco, Luanda, Angola.  
 Fig. 23. *Crassispira bernardi*. Holotype (MNCN). Cacuaco, Luanda, Angola.  
 Fig. 24. *Crassispira monilecosta*. Holotype (MNCN), Farol das Lagostas, Luanda, Angola.  
 Fig. 25. *Crassispira monilecosta*. Holotype (MNCN), Farol das Lagostas, Luanda, Angola.  
 Fig. 26. *Crassispira pini*. Holotype (MNCN). Senegal.  
 Fig. 27. *Crassispira pini*. Paratype (CER). Senegal.  
 Fig. 28. *Crassispira pini*. Protoconch. Paratype (CER).  
 (scale bar, shells, 5 mm; protoconch, 0.5 mm)



***Crassispira callosa* (Valenciennes, 1840)**

(Figs. 12, 13, 14, 33, 34)

*Turris callosa* Valenciennes, (1840): *In*: Kiener (1839): p. 50, pl. 18, figs. 1.

*Drillia callosa* Valenciennes. Tyron (1884): p. 192, pl. 13, fig. 63.

*Crassispira callosa* (Valenciennes). Nicklés (1950): 127, fig. 256.

*Crassispira callosa* (Valenciennes) Kiener 1839–40. Maltzan (1883): p. 120, pl. 3, fig. 3.

*Turris callosa* Kiener. Knudsen (1952): p. 162, pl. 2, fig. 5.

*Crassispira callosa* (Kiener, 1839–1840). Bernard (1984): p. 100, pl. 49, fig. 189.

*Type material*: Neotype (Fig. 14) 36.9 mm, ex CER, here designated, MNHN.

*Type locality*: Dakar, Senegal is here designated as type locality.

*Other material examined*: *Senegal*: 1 specimens, Dakar (CER); 17 specimens, I. Gorée, at 15–20 m (CMP); 2 shells, Cap Vert, Mauny collection (MNHN); 2 specimens, Baie de Dakar, at 30 m, Staadt collection (MNHN); 2 shells, Illes Bissagos, Mission L. Gain, 1913, (MNHN); 6 shells, I. Gorée, at 15–25 m, (MNHN); 1 specimen, between Tacoma and Bel Air, at 14–16 m, (MNHN); 1 shell, Lorois collections, (MNHN); 1 shell, Baie Gorée, at 12–25 m, (MNHN); 1 shell, SEE Gorée, 14°41'N, 17°23,3'W at 19 m, (MNHN).

*Sierra Leone*: 1 shell, 9°25'N, 13°48'5W (MNHN); 1 shell, at 10 m, (MNHN).

*Ghana*: 6 adult specimens and 15 juveniles, Miamia, at 20–25 m (CER).

*Republic of São Tomé and Príncipe*: 2 specimens, Cais de S. Ana, at 11 m, Calypso (1956), (MNHN); 1 specimen, at 8–10 m, Calypso (1956), (MNHN).

*Equatorial Guinea*: 2 specimens from Rio Muni (CER).

*Gabon*: 2 shells, Port-Gentil, Libreville, at 20–25 m, (MNHN); 1 shell, Cap Sterias, point Idolo, intertidal, (MNHN).

*Measurements*: The specimens from Gabon are smaller (about 30 mm) than those from Dakar (from where a decollated specimen reached more than 50 mm).

*Description*: See Kiener (1839). The species has been described and illustrated by Kiener (1838, pl. 18, fig. 1). It is very important to point out from Kiener's description: “. . . de huit à neuf tours subcarénés . . . ;”, “. . . petites côtes obsolètes longitudinales et régulières qui s'effacent insensiblement et finissent par disparaître sur les autes tours; on remarque sur toute la surface de la coquille des stries transverses fines et irrégulières;” and also: “A l'exterior cette coquille est d'un noir grisâtre”. The shells (Figs. 12–14) studied from Senegal to Gabon, have small differences but are perfectly compatible with this description: they have a size between 30–45 mm, are decollated, with axial sculpture in first whorls, being attenuated in the last one. The colour is dark brown to olive-brown, uniformly distributed, almost black in small specimens. The periostracum is brown, becoming darker in uncleaned shells; without this periostracum, the shell has a uniform olive-brown colour.

Operculum corneus, strong, oval-elongated, with a terminal nucleus.

Radula (Fig. 34) with 2 rows of about 50–55 pairs of marginal teeth. The tooth (Fig. 33) is lanceolate, slightly curved, without angulation, with a sharp point and with an accessory plate. The ratio LC/DR is about 160.

*Habitat*: Between 5 and 30 m deep in muddy bottoms.

*Geographical range*: Known certainly from Senegal to Gabon.

*Remarks*: The description of Kiener (1839) is short and not many characteristics are given. Obviously it was based on an undecollated specimen because 8–9 whorls are not usual in the studied material. This figure could be enough to define this species, and it would be the

lectotype. In the drawings, the spiral sculpture appears very evident and, also, there are axial blotches representing some kind of axial sculpture, these being less evident in the body whorl, as is mentioned in the description. We think that this figure may be confused, because, in the description text, the author is more explicit in the explanation of the sculpture of the last whorls, saying that the axial ribs disappear in them.

We had two populations which could be included in the description of the present taxon, but not perfectly, both having some similarity with the figures of Kiener (1839, pl. 8 figs. 1): one of them (Figs. 12, 13 & 14) has spiral sculpture on the body whorl but with the axial ribs attenuated; the other (Figs. 15, 16, 17 & 18) has no axial sculpture and slight spiral striae. No type was located and the concept of the species depends on the description and figure of Kiener (1839); therefore, it was necessary to decide which of these populations was correspondent with this taxon. We chose the first one because of its darker colour, the persistence of the spiral sculpture in its last whorl, and also because it is more abundant and better known, and usually it has been considered to be this taxon by most of authors. It was necessary to designate a neotype for nomenclatural stability. The chosen shell is very similar to Kiener's figure.

***Crassispira oliva* n. sp.**  
(Figs. 15, 16, 17, 18, 35, 36)

*Type material*: Holotype (Figs. 15 & 16), 33 mm, ex. CFF, deposited in MNCN, n° 15.05/18731. Single paratypes in AMNH, BMNH, CER, COS and CFF, from the type locality, at 10 m, ex. CFF; 4 paratypes, Cacuaco, MNHN.

*Type locality*: Farol das Lagostas, Luanda, Angola.

*Other material examined*:

*Congo Republic*: 7 specimens and 2 shells, Pointe Noire, Orstom Beach, at 3–4 m (MNHN); 24 specimens, Pointe Noire, Orstom Beach, at 5–7 m (MNHN); 1 shell Pointe Noire (Hattenberger coll.).

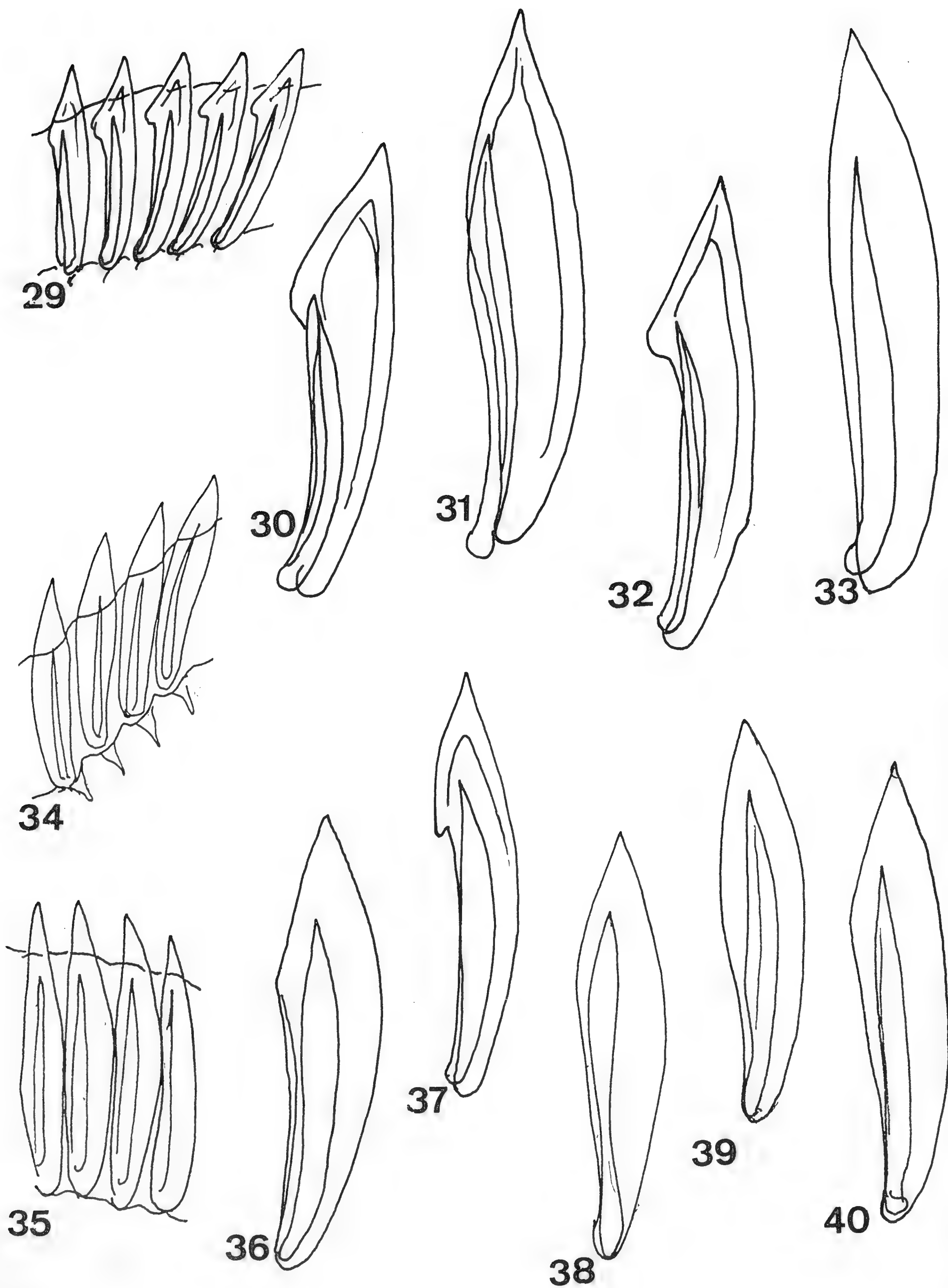
*Angola*: 6 specimens, Farol das Lagostas (Luanda), at 10 m (CFF); 2 specimens, Cacuaco, at 7 m (CFF); 2 specimens, Cacuaco, 7 m (CER); 5 specimens and 3 shells, Barra do Dande, prov, Bengo, infralittoral, (MNHN); 9 specimens, Cacuaco, prov. Bengo, infralittoral, (MNHN).

*Measurements*: To 35 mm in length in decollated specimens.

*Description*: Shell (Figs. 15, 16, 17 & 18) solid, elongate, clearly decollated, with 4–5 teleoconch whorls. Sculpture of about 15 narrow axial ribs, with wider spaces between them; on the last two whorls these ribs almost completely disappear. All over the shell are very weak spiral threads, almost imperceptible in the convexity of the whorls, and only thicker at the base. Suture well-marked, with a broad smooth subsutural margin, and below it, there is an angulated shoulder. Aperture oblong-elongate, with its outer edge slightly free. The stromboid notch is shallow but constant. Siphonal canal broad, slightly incurved. Anal sinus deep, U-shaped, a little narrowed by a broad flat fold in upper part of the columella. Olive green in colour, frequently with a yellowish subsutural band and similar colour at the base; aperture white, with parts of bluish-violet. Periostracum fine and brown, giving a darker colour to the shell when it is not removed (Fig. 17).

Opereculum pyriform, elongate, brown.

Radula (Fig. 35) with about 50 rows of teeth. The radular tooth (Fig. 36) is lanceolate, slightly curved, wider in the upper third, and with very minute angulation. Accessory plate present. The ratio LC/DR is about 150.





*Etymology*: The specific name is derived from the latin name *oliva* alluding to its olive green colour.

*Habitat*: Rocky bottoms with sand and mud, from intertidal level to 40 m.

*Geographical range*: Congo Republic to Angola.

*Comparisons*: This species can be differentiated from *C. callosa*, because it is shorter and broader; *C. callosa* has prominent axial ribs, still visible on the body whorl but attenuated in some specimens; also the spiral striation is more evident. The colour in *C. callosa* is darker and uniform, even without periostracum, while *C. oliva* is lighter, with a frequent yellowish subsutural band and also it is lighter at the base. The radular tooth of *C. callosa* lacks angulation. The distribution areas are not coincident which could make us think that both could be forms of a single species. The reason to accept the specific status for both was based on the strict similarity of the specimens of *C. callosa* from Senegal to Gabon, in opposition of the numerous and constant differences, with several uniform populations of *C. oliva*.

*C. carbonaria* and *C. funebris* are black and with more evident axial sculpture. *C. consociata* is smaller with prominent axial ribs and lighter in colour.

*Remarks*: *C. oliva* lives sympatrically with *C. funebris*, *C. consociata*, *C. monilecosta* and *C. barnardi* in Angola, and with *C. carbonaria* in Congo.

***Crassispira consociata* (E. A. Smith, 1877)**  
(Figs. 19, 20, 37)

*Pleurotoma consociata* E. A. Smith (1877): p. 496.

*Crassispira consociata* Edgar Smith, 1877. Maltzan (1883): p. 121, pl. 3, fig. 4.

*Drillia consociata* E. A. Smith, Tryon (1884): p. 192, pl. 30, fig. 81.

*Drillia consociata* Smith, var. *recordata*, n. var. Sykes (1905): p. 318, pl. 17, fig. 10.

*Turris consociata* (E. A. Smith). Knudsen (1952): p. 164, pl. 2, fig. 3.

*Crassispira consociata* (E. A. Smith, 1877). Bernard (1984): p. 100, pl. 52, fig. 191.

*Type material*: Holotype (Fig. 20), H. Cuming coll., BMNH, n° 1963811.

*Type locality*: With the holotype there is a label which states "Locus:—?", but in an old label accompanying the type is written: "Gorée P (Maltzan)".

Gorée Bay in Dakar is a place where this species is relatively common and the shells are very similar to the holotype. For these reasons we regard it may be the type locality.

Fig. 29. Radula of *Crassispira carbonaria*.

Fig. 30. Radular tooth of *Crassispira carbonaria*. Size: 0.21 mm (shell of 25 mm from Orstom, Congo).

Fig. 31. Radular tooth of *Crassispira funebris*. Size: 0.23 mm (shell of 28.8 mm from Farol das Lagostas, Luanda, Angola).

Fig. 32. Radular tooth of *Crassispira* sp. Size: 0.20 mm (shell of 34 mm from Port-Gentil, Gabon).

Fig. 33. Radular tooth of *Crassispira callosa*. Size: 0.19 mm (shell of 28.8 mm from Miamia, Ghana).

Fig. 34. Radula of *Crassispira callosa*.

Fig. 35. Radula of *Crassispira oliva*.

Fig. 36. Radular tooth of *Crassispira oliva*. Size: 0.20 mm (shell of 30.2 mm from Farol das Lagostas, Luanda, Angola).

Fig. 37. Radular tooth of *Crassispira consociata*. Size: 0.21 mm (shell of 24.6 mm from Farol das Lagostas, Luanda, Angola).

Fig. 38. Radular tooth of *Crassispira sacerdotalis*. Size: 0.09 mm (shell of 9.1 mm from Esprainha, São Tomé I.).

Fig. 39. Radular tooth of *Crassispira barnardi*. Size: 0.19 mm (shell of 23.6 mm from Cacucaco, Luanda, Angola).

Fig. 40. Radular tooth of *Crassispira monilecosta*. Size: 0.09 mm (shell of 21.6 mm from Farol das Lagostas, Luanda, Angola).

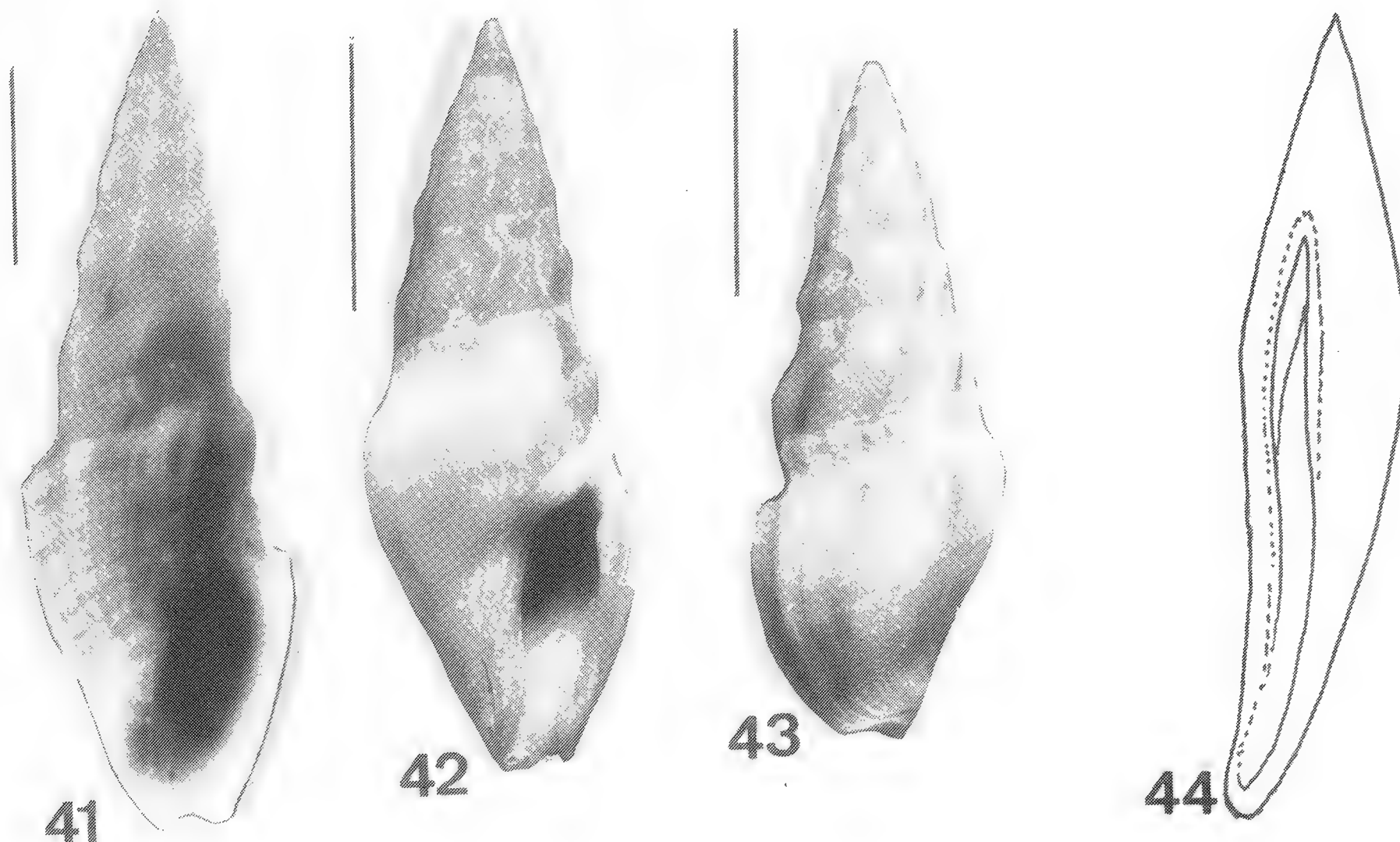


Fig. 41. *Crassispira laevisulcata*. Dakar, Senegal (CPR).

Fig. 42. *Crassispira laevisulcata*. Dakar, Senegal (CER).

Fig. 43. *Crassispira laevisulcata*. Dakar, Senegal (CER).

(scale bar 5 mm)

Fig. 44. Radular tooth of *Crassispira laevisulcata*. Size: 0.115 mm (shell of 13.5 mm from Dakar, Senegal).

*Other material examined: Unknown locality:* one shell, collection of Jousseume, (MNHN).

*Senegal:* 34 specimens, I. Gorée, at 15–20 m, (CMP).

*Guinea Conakry:* 7 shells, at 10–20 m, (CMP).

*Cameroun:* 1 specimen at 45 m (MNHN).

*Gabon:* 1 shell, at 35 m (MNHN).

*Congo Republic:* 2 shells, Pointe-Noire, (MNHN).

*Angola:* 4 specimens, Farol das Lagostas, Luanda, at 15–20 m (CFF); 2 specimens, Palmeirinhas, Buraco, infralittoral, (MNHN).

*Measurements:* The holotype is 20.4 mm in length, as are most mature shells from Senegal. Some shells from Gabon and Cameroun reach 30 mm.

*Description:* The specimens studied (Fig. 19 & 20) have a solid shell, slightly decollated, with strong, interrupted, axial ribs crossed by several spiral threads. The stromboid notch is quite deep. The anal sinus is deep, U-shaped, but only slightly narrowed by a thin subsutural fold. Colour light brown to cream, with the aperture and the inner shell bluish-white. Some shells from Guinea Conakry are almost white. The periostracum is thick, brown or blackish. Operculum solid, elongated, dark brown and curved.

Radula of about 20 pairs of marginal teeth. Tooth (Fig. 37) elongated, with slightly curved and narrow base; there is a barb between the middle and upper third. The accessory plate is shorter, narrower and grooved. Ratio LC/DR is about 117.

*Habitat:* Infralittoral rocky bottoms.

*Geographical range:* Knudsen (1952) records it from Senegal to Nigeria. This distributional area must be enlarged to include Angola.

*Remarks:* This species has been included in the genus *Drillia* by several authors; besides conchological differences, the radula is not compatible with that genus, which has a central and two lateral teeth as well as two marginals. It can be differentiated from *C. callosa* and *C. carbonaria* by its small size, lighter colour and its smaller number of axial ribs.

*Crassispira consociata* var. *recordata* Sykes, 1905, pl. fig. 10, may be a variety of this species or perhaps, and more probably, a species of *Drillia*.

***Crassispira sacerdotalis* Rolán & Fernandes, 1992**

(Figs. 21, 38)

*Crassispira sacerdotalis* Rolán & Fernandes, 1992: p. 138, figs 3, 4, 12 & 13.

*Type material:* Holotype (Fig. 21) MNCN, n° 15.05/2679 and 25 paratypes (4 specimens and 10 shells, Esprainha, Sao Tomé Island) CER.

*Type locality:* Esprainha, São Tomé Island.

*Measurements:* Between 8 and 10 mm in length.

*Description:* See Rolán & Fernandes (1992). Shell (Fig. 21) elongate, six whorls, numerous spiral threads crossed by axial ribs, 10–13 in body whorl. Aperture elongate, black in its inner part; anal sinus U-shaped, siphonal canal short and broad. Protoconch with one spiral whorl, smooth and with a peripheral angle. Radula described in Rolán & Fernandes (1992), though the presence of an accessory plate (Fig. 38) was not mentioned. Ratio LC/DR = 100.

*Habitat:* On rocks, between 2–5 m.

*Distribution:* Endemic to São Tomé Island.

*Remarks:* This species is smaller than other African *Crassispira*, but it has the typical characteristics of the genus, and also, because of its black colour, it is more similar to the American species.

***Crassispira bernardi* n. sp.**

(Figs. 22, 23, 39)

*Drillia* sp. Bernard (1984): p. 102, fig. 197.

*Type material:* Holotype (Figs. 22 & 23), 23.6 mm, ex. CFF, in MNCN, n° 15.05/18728. Paratypes: 5 in the MNHN (*Ivory Coast*: 1 shell, Assinie, Abidjan, at 20 m; *Congo Republic*: 2 shells, Baie de Pointe-Noire, Songolo, at 5–6 m; 2 specimens, Plage Orstom, Pointe-Noire, at 3–4 m); *Ghana*: 1 shell, Takoradi, at 10 m, CPR; 1 shells, Takoradi, at 10 m, COS; 1 shell, Miemia, at 20 m, CER; *Angola*: 2 shells, Farol das Lgostas, Luanda, CFF; 1 specimen, Farol das Lagostas, Luanda, CER;

*Type locality:* Cacuaco, Luanda, (Angola).

*Other material examined:* *Gabon*: 1 shell, Pointe-Noire, Hattenberger collection.

*Etymology:* It is named after Pierre A. Bernard, malacologist who illustrated this species in his book on the Gabon shells.

*Measurements:* Length about 25mm.

*Description:* Shell (Figs. 22 & 23) rather solid, strongly decollated, 5–6 teleoconch whorls remaining. Sculpture of about 10 axial ribs in the first remaining teleoconch whorl, 12 in the next, and 17 in the body whorl, here slightly oblique; spiral threads only present on the shoulder and on the base, with little nodules at the crossing points. Suture well-marked, with



a quite broad subsutural margin, formed by a row of nodules. Aperture quite elongate, with a sharp free outer lip. The stromboid notch is shallow. Siphonal canal broad, slightly incurved, and thicker. Anal sinus very deep, U-shaped, slightly narrowed by a quite thick subsutural fold. The ground colour is variable between light brown and cream-orange; spaces between the ribs blackish; subsutural band yellowish, with a row of black spots in the depressed parts; the crossing points of the axial ribs with the spiral threads are whitish; aperture whitish, slightly bluish in the interior.

Radula with around 38 rows of marginal teeth; tooth (Fig. 39) lanceolate, slightly curved and narrowed at the base. Accessory plate slightly smaller, rising from the base to  $\frac{3}{4}$  of the length of the tooth.  $LC/DR = 124$ .

*Habitat*: Rocky bottoms, with sand and mud, between 5–20 m.

*Geographical range*: Ivory Coast to Angola.

*Comparisons*: From its colour pattern and the subsutural nodulous band it can be differentiated from the above mentioned species.

*Remarks*: This species could be included in genus *Inquisitor* Hedley, 1918 because of its subsutural tuberculated space, as in the type species, *Pleurotoma sterrha* Watson, 1881. Its decollation and its marginal tooth without any barb and with an accessory plate are different from those of *Inquisitor* cf. *crenularis* (Lamarck, 1816) and *I. griffithii* (Reeve, 1843), represented in Powell (1966, figs. 104, 105). Therefore, we retain it in the genus *Crassispira*.

In Tryon (1884, pl. 13, fig. 63) there is a figure of *C. callosa*, which could be this species because of the dark colour in the rib interspaces.

***Crassispira monilecosta* n. sp.**

(Figs. 24, 25, 40)

*Type material*: Holotype (Figs. 24, 25), 22.0 mm, ex. CFF, MNCN n° 15.05/18729. Paratypes: One in each of the following: MNCN, AMNH, BMNH, ZMA, MNHN, CER, COS, NMW, CPR, CMP, and 42 in CFF.

*Type locality*: Farol das Lagostas, Luanda (Angola).

*Measurements*: Length about 22 mm in decollated specimens; width 10 mm.

*Description*: Shell (Figs. 24 & 25) rather solid, elongate, strongly decollated, 4–5 teleoconch whorls remaining. Sculpture of about 12 narrow axial ribs in the first remaining teleoconch whorl, and 13 in the following, with wider spaces between them; in the last half whorl, these spaces are broader, there being only 5–6. The last axial rib – being the labial callosity – is very prominent, protruding out of the profile of the shell. The spiral sculpture is formed by clear but low spiral threads, 5 in the penultimate whorl and 26 in the body whorl; a fine microstriated sculpture can be seen on these spiral threads. The crossing points are slightly nodulous in the middle part of the body whorl. Suture well-marked, with a quite broad subsutural margin, and below it an angulated shoulder, with small nodules in which begin the axial ribs. Aperture elongate, with its outer edge clearly free. The stromboid notch is shallow, though very constant. Siphonal canal quite broad, slightly incurved. Anal sinus deep, U-shaped, a little narrowed by a thin flat subsutural fold. Light-brown colour, with a darker band from below the shoulder; last whorl has another lighter band below this, followed by another not so dark, and the base being clear. Some specimens do not show this pattern clearly, the lower middle of the last whorl being lighter; the crossing points of the axial ribs with the spiral threads are whitish; aperture white, with violet areas. Periostracum fine and dark-brown, giving a blackish colour to the shell when it is not removed.

Operculum brown, pyriform and elongated.

Radula with 37 pairs of marginal teeth interlinked through a membrane. The tooth (Fig. 40) is elongated and sharp, wider in its upper third, one of its margins is slightly curved, and the other has an angulation, without a barb, at 1/5 length of the apex. There is a small and narrow accessory limb.  $LC/DR = 223$ .

*Etymology*: The specific name is derived from the latin names *monile*, necklace, and *costa*, rib, alluding to the prominent lighter nodulose axial sculpture.

*Habitat*: Rocky bottoms with sand and mud, between 15–20 m.

*Geographical range*: Only certainly known from Angola.

*Comparisons*: *Crassispira monilecosta* is different from *C. callosa* because this is larger than the former, of uniform colour, higher spiral threads, and more numerous axial ribs (10–13 in the last whorl in *C. monilecosta* and between 18–25 in *C. callosa*), which are very irregular in *C. callosa*, while very regular in *C. monilecosta*. Both species have a very different ratio  $LC/DR$ . *C. carbonaria* is uniform black, larger and with more irregular and less evident spiral striation. Also *C. funebris* is black and lives sympatrically with it. *C. oliva* is larger, of a uniform olive green colour, and almost without axial sculpture in the last whorls.

***Crassispira pini* n. sp.**  
(Figs. 26–28)

*Turris* (*Crassispira*) *laevisulcata* von Maltzan. Niclés, 1950; p. 127, fig. 258.

*Type material*: Holotype (Fig. 26) of 9.8 mm, ex. CMP, MNCN n° 15.05/18727. Paratypes: 1 in AMNH, MNHN, BMNH, COS, CFF, 3 in CER and 6 CMP.

*Type locality*: Dakar, Senegal.

*Measurements*: To 11 mm in length.

*Description*: Shell (Figs. 26 & 27) rather solid, oval elongated. Protoconch (Fig. 28) with a little more than 1 rounded smooth whorl. Teleoconch with 4.5–6.5 spiral whorls. Sculpture of about 11 axial ribs in the first teleoconch whorl, closer than in the following whorls, and 10–12 in the following, with wider spaces between them; in the last half whorl, the ribs become more numerous and irregular, confused with growth striae. Towards the base there is no sculpture. Spiral sculpture formed by slight low spiral threads, which are nearly lost in the subsutural zone, there being 6 in the first whorl of the teleoconch and about 8 in the second. The body whorl has 14–16 main spiral threads in the subsutural zone, with another finer between them. These threads are stronger towards the base. Suture undulate because of the ribs of the previous whorls. Aperture elongate, with a short and broad siphonal canal, which is not well differentiated. Anal sinus deep, U-shaped, with a little developed columellar callous. Inner aperture smooth; sharp border without any external reinforcement. Stromboid notch shallow. The whole shell is dark-brown in colour, with a clearer zone in the first 2 teleoconch whorls. Periostracum very fine and dark-brown.

Operculum brown, elongated and pyriform.

Radula not studied.

*Etymology*: It is named after the malacologist Marcel Pin, resident in Dakar, who collected the type material.

*Habitat*: Under rocks, intertidal.

*Geographical range*: Only known from Dakar, Senegal

*Comparisons:* *C. pini* n. sp. is probably the species illustrated by Nicklés (1950, fig. 258) under the name *Turris (Crassispira) laevisulcata*; but *C. laevisulcata* (Maltzan, 1883), is larger, of whitish-grey colour, and its protoconch has three and half spiral whorls.

The only similar African species of the genus is *Crassispira sacerdotalis*, but this is black instead of dark brown, and the protoconch (represented in Rolán & Fernandes, 1993, fig. 4) is different in form, with an marked peripheral angle.

***Crassispira laevisulcata* (von Maltzan, 1883)**

(Figs. 41, 42, 43, 44)

*Drillia coccinata* Reeve. Tryon (1884): p. 188, pl. 13, fig. 54, pl. 30, fig. 85.

*Crassispira laevisulcata* n. Maltzan (1833): p. 122, pl. 3, fig. 6.

*Crassispira laevisulcata* (von Maltzan) Dautzenberg (1913): p. 13.

*Type material:* Not examined.

*Type locality:* Gorée, Dakar, Senegal.

*Other material examined:* Senegal: 9 specimens and 10 shells, Gorée Isle, Dakar, rocky bottom (CMP) and 6 shells (CER).

*Measurements:* Length about 20 mm in largest specimens.

*Description:* Shell (Figs. 41, 42 & 43) rather solid, oval elongated. Protoconch sharp with 3 1/2 smooth whorls. Teleoconch with 7–8 spiral whorls, sculptured by 6–7 axial ribs in the first teleoconch whorl, with wider spaces between them; in the body whorl, there are 8–10 ribs. Spiral sculpture formed by numerous spiral threads. Aperture elongate, with a short and broad siphonal canal. Anal sinus shallow. Inner aperture smooth; sharp border with thin external reinforcement. Stromboid notch shallow. The shell is cream to light-brown in colour, sometimes with reddish brown spiral lines. Protoconch reddish.

Operculum corneus, brown, elongate.

Radula (Fig. 44) with about 70 pairs of marginal teeth sharp, wide in its middle part and with smaller accessory plate. The ratio LC/DR is about 117.

*Habitat:* Infralittoral rocky bottoms.

*Geographical range:* Only known from Dakar, Senegal

*Remarks:* The shell represented by Nicklés (1950) as *Turris (Crassispira) laevisulcata* is not this species but *C. pini*. Initially, this species was not included in the study because on shell characters it seems to be in other genus. However, the radular structures led us to consider this species as a *Crassispira*.

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# GEORG MANDAHL-BARTH (1910–1994): HIS LIFE, PUBLICATIONS AND DESCRIBED TAXA

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## BIOGRAPHY

Dr Georg Mandahl-Barth died at his home on the west coast of Denmark, on the 19th April 1994, in his eighty fourth year. His publications on the Mollusca were mostly on the taxonomy of freshwater gastropods and bivalves of Africa. He was well known internationally for his monographic revision of the planorbid genera *Biomphalaria* and *Bulinus* (1957, 1958). These snails are of medical importance, for some species serve as intermediate hosts in the life cycle of parasites belonging to the trematode genus *Schistosoma*, which complete their development as blood parasites of man, causing the disease schistosomiasis (bilharziasis).



George Mandahl-Barth (right) and the late Christopher Wright at the Danish Bilharziasis Laboratory in 1972.

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Born in Copenhagen in 1910, the nine-year old Georg barely survived a serious infection of his ear, which left him with a damaged jaw and poor hearing. While in hospital he overheard a nurse say to his mother that it would be best for him to die, as if he survived he would surely be mad. The boy became intensely interested in natural history and in his 14th year his attention was switched from moths to molluscs, when he found a shell that he thought was a new green-coloured species of *Helix*, but which turned out to be a long dead specimen of *nemoralis* covered with algae. He filled notebooks with hundreds of pencil drawings of shells copied accurately from books, and thus acquired the skill with which he later would illustrate his own publications. Passing the entrance exam to the University of Copenhagen in classical languages, Mandahl-Barth then studied Zoology, gained his Master's degree in 1936 and became a temporary assistant in the University Museum. Disappointed at not obtaining a permanent post there, he accepted the appointment as Inspector (Deputy Director) of the recently-opened Dansk Akvarium at Charlottenlund, a northern suburb of Copenhagen.

Mandahl-Barth continued his molluscan activities, working on the dining table in his residential flat above the Akvarium. His study of the landsnails of Madeira was accepted as a doctoral thesis by the University of Copenhagen in 1943 and sent to Frankfurt for printing. Publication was delayed for 7 years, however, at first due to the destruction of printing presses by the wartime bombing, which obliged him to correct proofs no less than seven times. Then the manuscript was sent to Luxembourg, where it was impounded by a printer as 'spoils of war'.

In the 1940s Mandahl-Barth turned his attention to the molluscs of Africa and by the early fifties he had identified several collections of freshwater snails obtained during early surveys of schistosomiasis transmission, sponsored by the World Health Organisation. He visited Uganda in 1951 to make collections, in collaboration with his compatriot Cai Cridland, then at the East African Fisheries Organisation, Jinja. This was the only substantial field work carried out in Africa by Mandahl-Barth; for other materials he depended on numerous collectors, among whom may be mentioned C. C. Cridland, P. L. LeRoux, F. S. McCullough, C. Ripert and J. J. Symoens. In 1952 the WHO awarded to his services, still performed in his home, the title "WHO Snail Identification Centre". By the late 1950s Mandahl-Barth was the leading authority on the freshwater molluscs of Africa. Impressed by this achievement, the Knud Hølgård Foundation (founded by wealthy Danish engineer) granted funds for the construction, near to the Akvarium, of a laboratory to be devoted to the study of schistosomes and their snail intermediate hosts. This opened in 1964, as the Danish Bilharziasis Laboratory (DBL), with Mandahl-Barth as Director. When he retired from the DBL in 1978, the research carried out there in malacology and parasitology had achieved a high reputation, providing the foundation from which has developed the present major centre concerned with several water-related parasitic diseases in the tropics.

I was fortunate to know Georg Mandahl-Barth for over 30 years. From the beginning of our friendship, at the Akvarium in 1963, he gave me the freedom of his collection and library, and I benefitted also from his guidance to the classic molluscan literature. Without his early encouragement, which nurtured my interest in the large fauna of African freshwater gastropods besides those of medical importance, I probably would not have attempted the broad systematic synopses in my own books.

Mandahl-Barth was a good general naturalist. Familiarity with Greek and Latin gave him a scholarly pleasure in nomenclature, and he was fluent in several modern languages (four different ones were used in his first six publications). He spoke English with precision, wit and a dry humour, and was appreciative of English pipe tobacco. Although polite and kindly, he did not enjoy public occasions and hardly ever attended a scientific meeting. He was reluctant to travel even so far as central Copenhagen, and told me that he would have

preferred the DBL have been built on a remote part of the Jutland coast, reachable by only the most determined visitors. This reclusiveness was partly because he carefully guarded his time against trivial activities, as he saw them. He was reluctant to devote time to an investigation after he had satisfied his curiosity and he was not much concerned about communicating his findings in print. He met his wife-to-be, Gudrun, while they both were students and they celebrated their Golden Anniversary shortly before her death in 1990. She constantly supported him by providing a quiet domestic routine, allowing Georg the maximum time for his varied interests, including the nightly operation of a light-trap for moths.

In his taxonomic investigation of gastropods, Mandahl-Barth was interested in a limited number of gross features, including the radula, copulatory organ and, above all, the shell. Likewise for bivalves, it was the shell that received most of his attention. His memory was extraordinarily and he seemed to know the exact position of each of thousands of tubes and boxes in his shell cabinets. He was not much impressed by the methods of experimental taxonomy, such as enzyme electrophoresis, for defining species. His opinions were expressed forthrightly, as when he asked me to tell my colleague Christopher Wright that the unusual cusps of the radula that Wright had described for a species of *Bulinus* were impossible. Rather annoyed, Wright immediately sent specimens for Mandahl-Barth to examine himself. Finding the cusps to be just as Wright had described, Mandahl-Barth apologised graciously and established these snails as the new taxon *B. reticulatus wrighti*, later recognised as a distinct species.

Outstanding publications produced during Mandahl-Barth's years at the DBL were revisions of the prosobranch genus *Potadoma* (1967) and the Bithyniidae (1968), and general faunal studies of the Bangweolo-Luapula region (1968), Lake Malawi (1972), south east Zaire (1972) and lower Zaire (1974). In addition he wrote anonymously a series of regional field guides for the identification of African freshwater snails, issued by the DBL in the 1970s. After retirement he was free to devote more time to bivalves, which he perhaps preferred to gastropods, but it seemed probable that his findings accumulated over 30 years would still remain unpublished. Fortunately the willingness of former colleagues at the DBL, Thomas Kristensen and Elaine Svenningsen, to edit his notes encouraged him to assemble his 'Studies of African freshwater bivalves' (1988), which ranks among his most important contributions.

Mandahl-Barth was also the author of a series of highly successful popular books on European wildlife, originally published in Danish. The first appeared in 1955 and dealt with fresh water, later subjects included forest and seashore. The combination of concise text, fine artwork in colour by Henning Anthon and low price produced large sales, numerous reprintings and translations into several other languages, including English (e.g. *Woodland Life*, Blandford Press, London, 1966).

During the early 1940s Mandahl-Barth observed that *Helisoma*, a planorbid of North American origin that is distributed widely over the world through the transportation of aquatic plants, was superceding *Biomphalaria* in the exhibition tanks of the Akvarium. Experiments he made in the 1960s led him to suggest that *Helisoma* produced some substance that inhibited the development of eggs and growth of other snails. The possibility of using a competing snail control intermediate hosts for schistosomes, rather than chemical molluscicides, attracted widespread interest, and in 1975 Mandahl-Barth was awarded a substantial prize by the medical company NOVO Nordisk. Although further research failed to confirm the existence of an inhibitory substance, the competitive superiority of *Helisoma* is real, and seems due to competition for food and physical stress to a 'weaker' species. The competitor is still a candidate for controlling intermediate host snails if standard procedures could be developed for establishing it under field conditions.

Mandahl-Barth's rich malacological library and collections remain in the DBL. The dry

collection is, at the time of writing, still in the order arranged by him and is of importance. It contains a large proportion of his type materials and numerous other series of shells identified by him, which in total are a valuable adjunct to his published descriptions, which are sometimes rather brief.

Few people enjoy conditions of employment and domestic life such as enabled Georg Mandahl-Barth to follow so freely his varied interests. The good use he made of his time was obvious to those like myself who talked with him and appreciated his wide knowledge of molluscs and natural history in general. Sadly that has passed away with him, but we may still admire the tangible achievements of what he published and the thriving Danish Bilharziasis Laboratory.

#### PUBLICATIONS BY G. MANDAHl-BARTH ON THE MOLLUSCA

(I am indebted to Thomas Kristensen and Bernard Verdcourt for adding titles and correcting errors of mine that would have annoyed G M-B)

1934 Den samsøske øgruppens land-og ferskvandsmollusker. En zoogeografisk og variationsstatistisk undersøgelse. *Vidensk. Meddr. dansk naturh. Foren.* **98**: 1–45, pls 1 and 2 (following p. 310).

1937 Recherches systématiques sur quelques espèces du genre *Geomitra* (Helicidae). *Vidensk. Meddr. dansk naturh. Foren.* **101**: 137–152.

1938 Land and freshwater Mollusca. *Zoology Iceland* **4**(65): 1–31.

1938 (with S. G. Hedding) Investigations on the anatomy and systematic position of the parasitic snail *Entocolax* Voigt. *Meddr. Grønland* **108**(5): 1–40.

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1957 Intermediate hosts of *Schistosoma*. African *Biomphalaria* and *Bulinus*: 1. *Biomphalaria*. *Bull. Wld Hlth Org.* **15**: 1103–1163.

1957. Intermediate hosts of *Schistosoma*. African *Biomphalaria* and *Bulinus*: 2 *Bulinus*. *Bull. Wld Hlth Org.* **17**: 1–65.

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- 1960 Intermediate hosts of *Schistosoma* in Africa. Some recent information. *Bull. Wld Hlth Org.* **22**: 565–573.
- 1962 Key to identification of East and Central African freshwater snails of medical and veterinary importance. *Bull Wld Hlth Org.* **27**: 135–150.
- 1965 The species of *Bulinus*, intermediate hosts of *Schistosoma*. *Bull. Wld Hlth Org.* **33**: 33–44.
- 1965 (with J-M. Doby, A. Chabaud and S. Deblock) Elimination de *Bulinus truncatus rivularis* (Philippi) de collections d'eau connues pour l'héberger par *Potamopyrgus jenkinsi* (Smith, 1889) (Hydrobiidae), et l'utilisation éventuelle de ce mollusque pour le contrôle biologique de bilharzioses. *C. r. hebd. Séanc. Acad. Sci., Paris* **261**: 4244–4246.
- 1966 (with J-M. Doby, A. Chabaud, B. Rault and H. Chevallier) Extension en Corse du mollusque gastropode *Potamopyrgus jenkinsi* (Smith, 1889). *Bull. Mus. Hist. nat., Paris* **37**: 833–843.
- 1967 Revision of the African genera *Potadoma* Gray and *Potadomoides* Leloup, and description of a new species of *Cleopatra*. *Revue Zool. Bot. afr.* **76**: 110–131.
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- 1970 Biological control of bilharziasis vector snails by *Helisoma*. In: *OAU Symposium on Schistosomiasis, Addis Ababa, 1970*: 233.
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- 1972 The freshwater Mollusca of Lake Malawi. *Revue Zool. Bot. afr.* **86**: 257–289.
- 1972 (with G. Malaisse and C. Ripert) Etudes malacologiques dans la région du lac de Retenue de la Lufira (Katanga). *Bull. Soc. Path. exot.* **65**: 146–165.
- 1973 Descriptions of new species of African freshwater molluscs. *Proc. malac. Soc. Lond.* **40**: 277–286.
- 1973 (with D. S. Brown) Two new genera of Planorbidae from Africa and Madagascar. *Proc. malac. Soc. Lond.* **40**: 287–302.
- 1973 (anonymously) *A field guide to African freshwater snails. Introduction*, 28 pp. 1: *West African species (Senegal-Nigeria)*, 29 pp. 2: *East African species*, 51 pp. 3: *North East African species*, 30 pp. Danish Bilharziasis Laboratory, Charlottenlund.
- 1974 New or little known species of freshwater Mollusca from Zaire and Angola, with remarks on the genus *Sierraia* Connolly. *Revue Zool. afr.* **88**: 352–362.
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- 1976 (with F. Frandson and J. E. Jeines) *Bulinus* sp. (2n = 36) from Salisbury, Rhodesia, a close relative of *B. truncatus* (Audouin) being a potential intermediate host for *S. haematobium* in southeast Africa. *Trans r. Soc. trop. Med. Hyg.* **70**: 88.
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 1987 (with D. S. Brown) Living molluscs of Lake Tanganyika: a revised and annotated list. *J. Conch., Lond.* **32**: 305–327.  
 1988 *Studies on African freshwater bivalves*. Danish Bilharziasis Laboratory, Charlottenlund. 161 pp.  
 1989 (with D. S. Brown) *A. Paludomus* (Thiaridae) twice mistaken for an African *Cleopatra*. *J. moll. Stud.* **55**: 551–553.

# MOLLUSCAN TAXA PROPOSED BY G. MANDAHL-BARTH

The list includes only the taxa of freshwater Mollusca named by G Mandahl-Barth, from Africa or Arabia (*wrighti* only).

## Gastropoda

### Genus-group names

- Acutorbis*** Mandahl-Barth, 1956, *Arch. Molluskenk.* **85**: 83. PLANORBIDAE. Replacement name for *Carinorbis* Mandahl-Barth, 1954.  
*Carinorbis* Mandahl-Barth, 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 98 (as subgenus of *Segmentorbis* Mandahl-Barth), *non* Conrad, 1862 *non* Yen, 1946. PLANORBIDAE.  
***Afrogyrus*** Brown & Mandahl-Barth, 1973, *Proc. malac. Soc. Lond.* **40**: 290. PLANORBIDAE.  
***Ceratophallus*** Brown & Mandahl-Barth, 1973, *Proc. malac. Soc. Lond.* **40**: 287. PLANORBIDAE.  
***Congodoma*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 155. BITHYNIIDAE.  
***Conogabbia*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 151 (as subgenus of *Gabbiella* Mandahl-Barth). BITHYNIIDAE.  
***Funduella*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 156. BITHYNIIDAE.  
***Gabbiella*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 132. BITHYNIIDAE.  
***Hovorbis*** Brown & Mandahl-Barth, 1973, *Proc. malac. Soc. Lond.* **40**: 292 (as subgenus of *Afrogyrus* Brown & Mandahl-Barth). PLANORBIDAE.  
***Jubaia*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 153. BITHYNIIDAE.  
***Lentorbis*** Mandahl-Barth, 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 92. PLANORBIDAE.  
***Liminitesta*** Mandahl-Barth, 1974, *Revue Zool. afr.* **88**: 352. BITHYNIIDAE.  
***Omphalogabbia*** Mandahl-Barth, 1968, *Revue Zool. Bot. afr.* **78**: 152 (as subgenus of *Gabbiella* Mandahl-Barth). BITHYNIIDAE.  
***Segmentorbis*** Mandahl-Barth, 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 94. PLANORBIDAE.

### Species-group names

The author in all cases was Mandahl-Barth alone. Type specimens are conserved in the Danish Bilharziasis Laboratory, Charlottenlund and, for some taxa, in the Natural History Museum as indicated below by their BMNH Registration Number.

- altior*** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 37, fig. 11 (as subspecies of *Bellamya jucunda* (Smith), VIVIPARIDAE), BMNH1968597.  
***angolensis*** 1974, *Revue Zool. afr.* **88**: 357, fig. 2 (*Melanoides*, THIARIDAE).  
***angulosa*** 1957a, *Bull. Wld Hlth Org.* **16**: 1141, pl. 13 (*Biomphalaria*, PLANORBIDAE). BMNH1995018.

- balovalensis** 1968, *Revue Zool. Bot. afr.* **78**: 150, pl. 3 (*Gabbiella*, BITHYNIIDAE).
- bennikei** 1974, *Revue Zool. afr.* **88**: 355, fig. 2 (*Pseudocleopatra*, THIARIDAE). BMNH1993073.
- bicarinata** 1967, *Revue Zool. Bot. afr.* **76**: 122, pl. 1 (*Potadoma*, THIARIDAE). BMNH1968699.
- bicarinatus** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 91, fig. 41 (*Gyraulus* PLANORBIDAE). BMNH1968677.
- butiabae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 58, fig. 24 (as subspecies of *Melanoides tuberculata* (Müller), THIARIDAE).
- camerunensis** 1957b, *Bull. Wld Hlth Org.* **17**: 31, pl. 22 (*Bulinus*, PLANORBIDAE). BMNH1968689.
- candida** 1968, *Revue Zool. Bot. afr.* **78**: 150, pl. 3 (*Gabbiella*, BITHYNIIDAE). BMNH1968693.
- concavus** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 89, fig. 40 (*Gyraulus*, PLANORBIDAE). BMNH1968676.
- crassus** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 90, fig. 40 (*Gyraulus*, PLANORBIDAE). BMNH1968600.
- cridlandi** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 61, fig. 27 (*Cleopatra*, THIARIDAE). BMNH1968599.
- cylindrica** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 62, fig. 27 (as subsp. of *Cleopatra cridlandi* Mandahl-Barth, THIARIDAE).
- dagusiae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 33, fig. 9 (as subsp. of *Bellamya unicolor* (Olivier), VIVIPARIDAE). BMNH1968593.
- dartevellei** 1973, *Proc. malac. Soc. Lond.* **40**: 281, fig. 3 (*Pseudocleopatra*, THIARIDAE).
- depressa** 1968, *Revue Zool. Bot. afr.* **78**: 152, pl. 4 (*Gabbiella*, THIARIDAE).
- edwardi** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 55, fig. 33 (as subsp. of *Gabbiella humerosa* (Martens), BITHYNIIDAE).
- eleanorae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 41, fig. 13 (as subsp. of *Pila ovata* (Olivier), AMPULLARIIDAE). BMNH1968592.
- elegans** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 82, fig. 36 (*Biomphalaria*, PLANORBIDAE). BMNH1968687.
- excavatus** 1968, *Expl. hydrobiol. Bangweulu-Luapula* **12**: 44, pl. 8 (*Segmentorbis* Mandahl-Barth, PLANORBIDAE).
- excentrica** 1968, *Revue Zool. Bot. afr.* **78**: 153, pl. 4 (*Jubaia*, BITHYNIIDAE). BMNH1993075.
- exilis** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 88, fig. 39 (as subsp. of *Gyraulus costulatus* (Krauss), PLANORBIDAE).
- incisa** 1968, *Revue Zool. Bot. afr.* **78**: 156, pl. 4 (*Funduella* Mandahl-Barth, BITHYNIIDAE). BMNH1968701.
- kavirondica** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 120, fig. 59 (*Ferrissia* Walker, ANCYLIDAE).
- kichwambae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 53, fig. 21 (*Gabbia* (Parabithynia) Pilsbry, BITHYNIIDAE). BMNH1968681.
- kivuensis** 1968, *Revue Zool. Bot. afr.* **78**: 137, pl. 2 (as subsp. of *Gabbiella humerosa* (Martens), BITHYNIIDAE).
- kivuensis** 1974, *Revue Zool. afr.* **88**: 358, fig. 3 (*Tomichia* Benson, POMATIOPSIDAE).
- kyogae** 1968, *Revue Zool. Bot. afr.* **78**: 134, pl. 2 (as subs. of *Gabbiella humerosa* (Martens), BITHYNIIDAE).
- luvilana** 1973, *Proc. malac. Soc. Lond.* **40**: 277, fig. 1 (*Hydrobia* Hartmann, HYDROBIIDAE).
- manzadica** 1957a, *Bull. Wld Hlth Org.* **16**: 1143, pl. 14 (subsp. of *Biomphalaria camerunensis*, (C.R. Boettger), PLANORBIDAE). BMNH1968685.



- matadina** 1968, *Revue Zool. Bot. afr.* **78**: 140, pl. 4 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE).
- nasutus** 1972, *Revue Zool. Bot. afr.* **86**: 265, pl. 6 (*Lanistes* Montfort, AMPULLARIIDAE).
- nyanzae** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 63, fig. 29 (*Cleopatra* Troschel, THIARIDAE).
- nyanzae** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 91 footnote (as subsp. of *Gyraulus kigeziensis* (Preston), PLANORBIDAE).
- oblonga** 1973, *Proc. malac. Soc. Lond.* **40**: 279, fig. 2 (*Eussoia* Preston, ASSIMINEIDAE).
- obscura** 1968, *Expl. hydrobiol. Bangweulu-Luapula*, **12**: 34, pls 1,7 (*Cleopatra* Troschel, THIARIDAE). BMNH1968700.
- obtus** 1973, *Proc. malac. Soc. Lond.* **40**: 283, fig. 4 (*Bulinus* (*Physopsis*) Krauss, PLANORBIDAE). BMNH1993071.
- parva** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 55, fig. 21 (*Gabbia* (*Parabithynia*) Pilsbry, BITHYNIIDAE). BMNH1968683.
- pilula** 1967, *Revue Zool. Bot. afr.* **76**: 130, pl. 2 (*Cleopatra* Troschel, THIARIDAE).
- productus** 1960, *Bull. Wld Hlth Org.* **22**: 568, pl. 2 (as subsp. of *Bulinus* (*Physopsis*) *nasutus* (Martens), PLANORBIDAE). BMNH1968697.
- pusilla** Mandahl-Barth (in Mandahl-Barth, Malaisse & Ripert), 1972, *Bull Soc. Path. exot.* **65**: 152, fig. 1 (*Lobogenes* Pilsbry & Bequaert, HYDROBIIDAE).
- reticulatus** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 109, fig. 51 (*Bulinus* (Müller), PLANORBIDAE).
- rhodesiensis** 1957a, *Bull. Wld Hlth Org.* **16**: 1126, pl. 4 (*Biomphalaria* Preston, PLANORBIDAE). BMNH1968688.
- rosea** 1968, *Revue Zool. Bot. afr.* **78**: 151, pl. 4 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE).
- rugosa** 1960, *Bull. Wld Hlth Org.* **22**: 566, pl. 1 (as subsp. of *Biomphalaria sudanica* (Martens), PLANORBIDAE).
- spiralis** 1968, *Revue Zool. Bot. afr.* **78**: 144, pl. 3 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE). BMNH1968692.
- subtilis** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 87, fig. 39 (as subsp. of *Gyraulus costulatus* (Krauss), PLANORBIDAE). BMNH1993070.
- sulcata** 1974, *Revue Zool. afr.* **88**: 353, fig. 1 (*Liminitesta* Mandahl-Barth, BITHYNIIDAE).
- tanganyicensis** 1968, *Revue Zool. Bot. afr.* **78**: 138, pl. 2 (as subsp. of *Gabbiella humerosa* (Martens), BITHYNIIDAE).
- tchadiensis** 1968, *Revue Zool. Bot. afr.* **78**: 144, pl. 3 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE). BMNH1968694.
- toroensis** 1960, *Bull. Wld Hlth Org.* **22**: 568 (as subsp. of *Bulinus* (*B.*) *tropicus* (Krauss). New name for *Bulinus* (*B.*) *tropicus mutandaensis* of Mandahl-Barth, 1957, 22, pl. 13, *partim*, non Preston, 1913. BMNH1968698.
- toroensis** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 119, fig. 59 (*Ferrissia* Walker, ANCYLIDAE).
- ugandae** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 32, fig. 8 (as subsp. of *Bellamya unicolor* (Olivier), VIVIPARIDAE). BMNH1968678.
- ugandae** 1954, *Annls Mus. r. Congo Belge*, 8 vo, *Zool.* **32**: 114, fig. 55 (as subsp. of *Bulinus globosus* (Morelet), PLANORBIDAE). BMNH1968679.
- ugandae** 1968, *Revue Zool. Bot. afr.* **78**: 148, pl. 3 (as subsp. of *Gabbiella senaariensis* (Küster), BITHYNIIDAE). BMNH1968695.
- umbilicatus** 1973, *Proc. malac. Soc. Lond.* **40**: 282, fig. 4 (*Bulinus* Müller, PLANORBIDAE).
- verdcourti** 1968, *Revue Zool. Bot. afr.* **78**: 143, pl. 4 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE).
- voltana** 1973, *Proc. malac. Soc. Lond.* **40**: 279, fig. 3 (*Pseudocleopatra* Thiele, THIARIDAE).

- wansoni** 1957, *Bull. Wld Hlth Org.* **16**: 1140, pl. 13 (as subsp. of *Biomphalaria alexandrina* (Ehrenberg), PLANORBIDAE). BMNH1968686.  
**wrighti** 1965, *Bull. Wld Hlth Org.* **33**: 41, (as subsp. of *Bulinus reticulatus* Mandahl-Barth, PLANORBIDAE). BMNH1966130.  
**zambica** 1968, *Revue Zool. Bot. afr.* **78**: 149, pl. 3 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE).  
**zambiensis** 1968, *Expl. hydrobiol. Bangweulu-Luapula* **12**: 50, pl. 2 (*Ferrissia* Walker, ANCYLIIDAE).

## Bivalvia

These are all species-group names and the author of all was Mandahl-Barth.

- albertiana** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 160, fig. 86 (as subsp. of *Corbicula africana* (Krauss), CORBICULIDAE). BMNH1968680.  
**albertianum** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 167, figs 87, 88 (as subsp. of *Sphaerium victoriae* Smith, SPHAERIIDAE).  
**crassa** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 178, fig. 96 (*Byssanodonta* SPHAERIIDAE).  
**cridlandi** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 135, fig. 70 (*Caelatura* (Zairia?) Rochebrune, UNIONIDAE). BMNH1968595.  
**fistulosum** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 174, fig. 93 (*Pisidium* Pfeiffer, SPHAERIIDAE).  
**kipopoensis** 1968, *Expl. hydrobiol. Bangweulu-Luapula* **12**: 54, pls 3, 10 (*Caelatura* Conrad, UNIONIDAE).  
**kyogae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 134, fig. 68 (as subsp. of *Caelatura hauttecoeurii* (Bourguignat), UNIONIDAE).  
**lacuum** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 166, figs 87, 88 (as subsp. of *Sphaerium victoriae* Smith, SPHAERIIDAE). BMNH1968598.  
**ovata** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 176, fig. 84 (*Byssanodonta*, D'Orbigny, SPHAERIIDAE). BMNH1968684.  
**ovoidea** 1988, *Studies on African freshwater bivalves*, 76, fig. 49 (as subsp. of *Spathopsis trapezia* (Martens), MUTELIDAE). New name for *Spatha caillaudi* of Mandahl-Barth, 154, 150, fig. 79, non Martens, 1866.  
**regularis** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 169, figs 87, 89 (as subsp. of *Sphaerium stuhlmanni* Martens, SPHAERIIDAE). BMNH1968596.  
**symoensi** 1968, *Expl. hydrobiol. Bangweulu-Luapula* **12**: 53, pls 3, 10 (*Caelatura* Conrad, UNIONIDAE).  
**triangularis** 1973, *Proc. malac. Soc. Lond.* **40**: 284, fig. 6 (*Eupera* Bourguignat, SPHAERIIDAE).  
**victoriae** 1954, *Annls Mus. r. Congo Belge, 8 vo, Zool.* **32**: 173, fig. 92 (*Pisidium* Pfeiffer, SPHAERIIDAE).  
**zambesiensis** 1988, *Studies on African freshwater bivalves*, 85, figs 81, 82 (*Mutela*, Scopoli, MUTELIDAE).

## TAXA OF AFRICAN FRESHWATER MOLLUSCA NAMED AFTER MANDAHl-BARTH

- barthi** Brown, 1973, *Proc. malac. Soc. Lond.* **40**: 369, pl. 1 (*Biomphalaria* Preston, PLANORBIIDAE).

**barthi** Jølnes, 1979, *J. Chromatography* **170**: 41; (*Bulinus* Müller, PLANORBIDAE).

**barthi** Brown, 1980, *J. moll. Stud.* **46**: 212, figs 5,6 (*Gabbiella* Mandahl-Barth, BITHYNIIDAE).

*MandahlBarthia* Biocca, Bullini, Chabaud, Nascetti, Orecchia & Paggi, 1979, *Atti Accad. naz. Lincei Rc. ser. 8*, **66**: 275, 281 (junior synonym of *Isidora* Ehrenberg, 1831).



# THE TERRESTRIAL MOLLUSCAN FAUNA OF SOME WOODLANDS IN NORTH EAST YORKSHIRE, ENGLAND

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*Abstract:* Terrestrial molluscan faunas are described from 17 deciduous woodlands in the north east of England. In total, 51 species were recorded (Mean number per site  $29.06 \pm 1.49$ , range 19 to 39) some of which are nationally scarce. The woodlands fall into two groups, the more easterly ones tending to be more species rich than those in the west. Species richness is positively associated with woodland area, moisture level and age. The species contributing to these associations are considered. Comparisons are made with other studies of woodland molluscan assemblages carried out elsewhere in Britain.

*Key Words:* Mollusc assemblages, woodland, Yorkshire, England.

## INTRODUCTION

Interest in the terrestrial molluscan fauna of north east Yorkshire seems to have begun as long ago as the mid 19th century, as evidenced by the works of local naturalists such as Dixon & Watson (1858) and Ferguson (1860). There followed the founding of the Conchological Society, in Yorkshire in 1876, and the establishment of the Cleveland Naturalists' Field Club in 1881, with some records for woodlands in the area to be found in those compiled by Taylor (1894–1921) and Hawell (1899). Nevertheless, publication of the *Atlas of non-marine Mollusca of the British Isles* (Kerney 1976) indicated that the status and distribution of these animals in the area concerned were not particularly well known. Furthermore, since then, there have been a number of taxonomic revisions which cloud existing knowledge, notably those for the genus *Arion* (Davies 1977, 1979 and 1987). Consequently, as part of a tetrad based mapping scheme of the terrestrial molluscs of Cleveland, an attempt has been made to survey, as comprehensively as possible, a number of deciduous woodlands in the area. The objectives were to find out to what extent faunal composition varies between woodlands and whether such variation is linked to physical factors. In addition, it was hoped that the results would indicate to what degree ancient and recent woodlands in the region might be distinguished by the composition of their molluscan fauna and how well this correlates with distinctions made on the basis of the presence or absence of plant species thought to be indicative of ancient semi-natural status. Lastly it was anticipated that the data collected could be used to develop a scheme for quality scoring woodlands in the area of their conservation value as regards the molluscan species present.

This article deals with variation in molluscan assemblages between woodlands and the association between species richness, certain physical factors and woodland age. It is intended that a second publication will cover the remaining aspects outlined above. Previous relevant studies of woodland Mollusca elsewhere in the British Isles include those of Cameron and Redfern (1972), Cameron (1973, 1978), Paul (1975, 1978a, 1978b), Bishop

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(1976, 1977) and Tattersfield (1990). Those carried out in other parts of Europe by Wäreborn (1969) and Waldén (1981) also make interesting comparison.

### METHOD

Seventeen woodlands were surveyed, fifteen being in north east Yorkshire (Watsonian vice county 62) and two in Durham (vice county 66). Their location is indicated in Figure 1 and Table 1. Details concerning altitude, area and geology provided in Table 1 were obtained from the relevant Ordnance Survey and British Geological Survey maps. An estimate of the dampness of each wood was made on a five point scale, the criteria for this being indicated in Table 2.

Recording of Mollusca was effected by a combination of searching on site and hand sorting of leaf litter and ground layer vegetation samples. Since recording was qualitative only, more exhaustive extraction methods such as removal of quadrat samples, which can cause significant habitat damage, or extensive sieving (eg Waldén, 1981) were deemed unnecessary. Each site was visited several times and at different times of year. Recording was considered to be complete when no new species were found after a minimum of 30 minutes additional searching, a procedure adopted for example by Tattersfield (1990). However, where very common species had not been recorded at a site, the woodland concerned was revisited with the particular aim of locating these. Thus searching was as complete as practicable. The whole of each woodland was surveyed in that all potential habitat types were searched. Overall, more time was spent in larger woods than in smaller

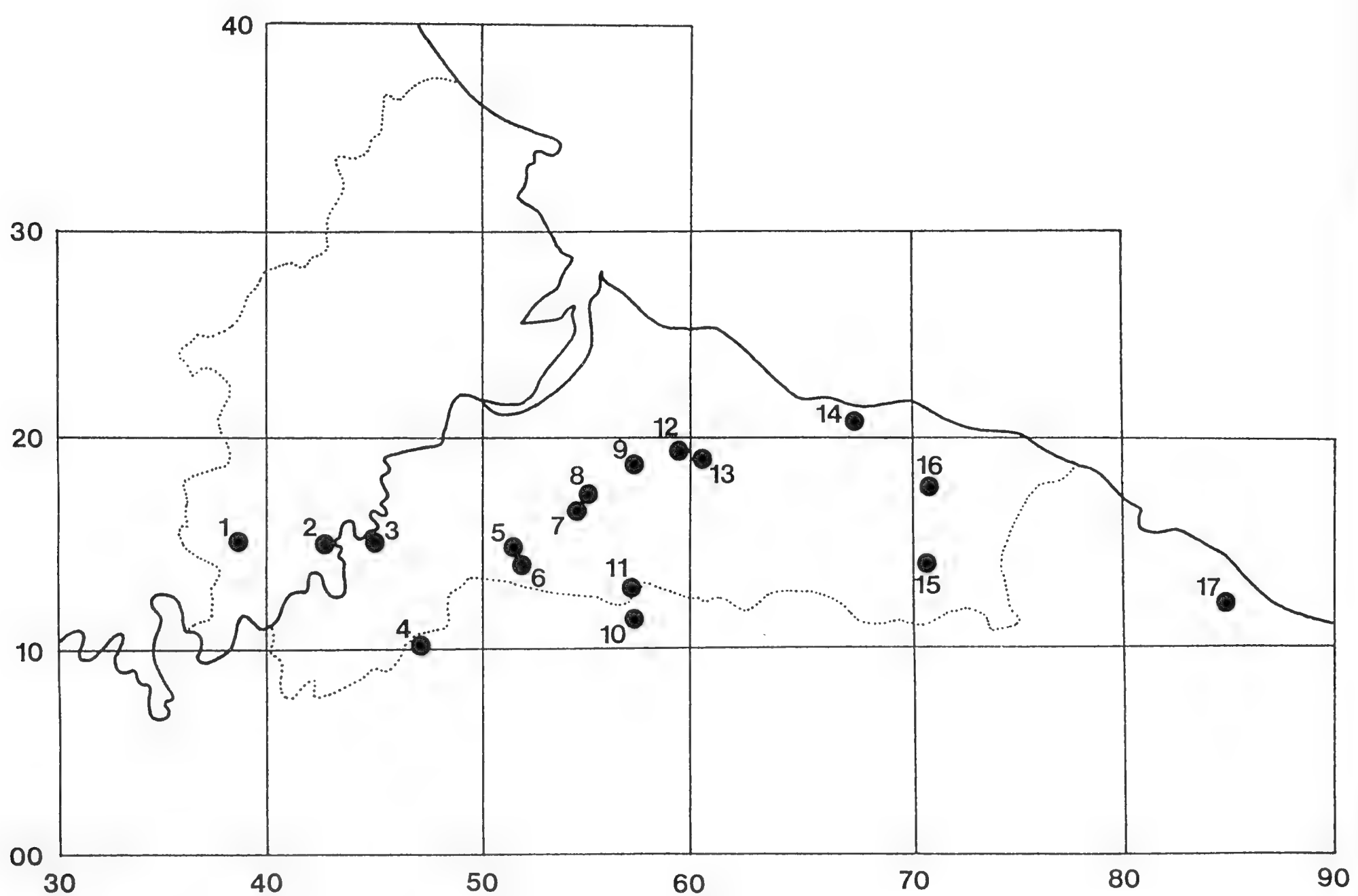


Fig. 1. Locations of the woodlands surveyed. All are within Ordnance Survey 100 km square 45(NZ). Grid lines at 10 km intervals are indicated.

TABLE 1  
General information about the woodlands surveyed  
\* = Potentially ancient (Cooke 1987; Carter 1987a, 1987b).

Site Number	Name	Grid Reference (100 km square 45)	Vice Count	Approximate Area (ha)	Approximate Altitude Range (m)	Predominant aspect of slope (if any)	Drift Geology	Moisture score	Dominant tree species
1	Burn Wood	386154	66	17	27- 35	—	Chiefly glacial boulder clay. Some post-glacial alluvium.	3	Sycamore, ash. (open canopy)
2	Eaglescliffe Wood	426149	66	1·5	10- 20	—	Glacial clay and glacial lake sand.	1	Ash, sycamore.
3*	Bassleton Wood	445115	62	5	8- 15	W	Boulder clay.	1	Sycamore, ash, willow. Some oak, & horse chestnut.
4	Brewsdale Wood	465106	62	3·5	20- 40	—	Boulder clay.	3	Ash, sycamore.
5	Marton West Beck	517145	62	1·5	45- 50	NW	Boulder clay.	2	Sycamore. Some ash, willow, oak.
6	Bonnygrove	519142	62	4	50- 65	—	Boulder clay.	2	Ash, sycamore.
7	Great West Plantation	546166	62	10·5	90-130	N	Lias; Whitby and Redcar mudstones.	0	Some oak.
8	Woodcock Wood	550170	62	5	70- 80	—	Boulder clay.	2	Ash, sycamore, birch. Some oak.
9	Lazenby Bank	573190	62	19	65-130	N	Boulder clay. Lower lias shale. Middle lias marl, shale, sandstone and ironstone.	2	Sycamore. Some ash, birch, oak, beech.
10*	Cliff Ridge Wood	574115	62	5	140-200	SW	Boulder clay. Middle lias marl and shale.	0	Oak. Some sycamore.
11*	Newton Wood	575124	62	22	130-210	W	Lower lias shale. Middle lias marl, shale, sandstone and ironstone.	1	Oak. Some sycamore.
12*	Wilton Wood	593197	62	42	60-110	—	Lower lias shale. Middle lias marl, shale, sandstone and ironstone.	3	Ash, sycamore. Some oak, lime, beech
13*	Dunsdale Wood	601190	62	8·5	90-100	—	Boulder clay.	2	Mixed beech, oak ash, sycamore.
14*	Saltburn Gill	675208	62	11·5	10- 50	—	Boulder clay.	2	Oak, ash. Some sycamore.
15*	Avens Wood	703139	62	10	120-150	—	Boulder clay. Middle lias marl, shale and sandstone.	2	Oak, beech,ash.
16*	Kilton Wood	707180	62	50	30-100	—	Boulder clay. Middle lias marl, shale and sandstone.	2	Sycamore, oak, ash. Some birch and alder.
17*	Mulgrave Woods	845118	62	200	10-130	—	Boulder clay.	2	Mixed. Oak, ash beech, sycamore.



TABLE 2

Scale used for scoring moisture level of woodlands.

Score	Description
0	Virtually dry throughout at all times of year except after prolonged, heavy rain.
1	Seasonally dry throughout or else permanently damp areas very restricted in size (ie. under about 10 square metres in total and lacking hygrophilous vegetation).
2	Some permanently damp areas of restricted size eg. stream banks.
3	Some areas wet throughout the year and well established as such eg. marsh.
4	Wet throughout at all times of year eg. carr woodland. (Nb. no woodlands of this category in the present study).

ones but there was no attempt to keep searching time directly proportional to woodland area.

In any study of this kind, it has to be admitted that there will always be uncertainty about the level of completion of the surveys; inevitably some species are overlooked at some sites. With enough care however, these should be sufficiently few that any underlying patterns are not significantly altered and thus such conclusions as can be drawn remain soundly based. In this context, some preliminary remarks are important.

Slug species were included in this study even though they can be overlooked, especially for example in dry weather when these animals retreat below ground to avoid dessication. This problem can be overcome by making sufficient visits to each site at appropriate times, as was done for example by Tattersfield (1990). In fact potentially greater difficulties arise with some small species of snail which rarely, if every, occur at other than low densities, *Acanthinula aculeata* and *Punctum pygmaeum* being examples. Nevertheless, it is thought that most smaller species of mollusc were located in the present study by careful hand sorting of litter and vegetation samples. However, it is inevitable that this kind of survey probably will be biased to a slight but unknown extent against small species occurring at low density or those with a limited distribution within the area surveyed.

A few of the 51 species recorded require special comment as regards identification because some are not always easy to distinguish with certainty. Thus on occasions some specimens of the genus *Cochlicopa* can be difficult to assign to either *C. lubrica* or *C. lubricella*. Populations of these two species are often quite distinct in both size and appearance but nevertheless some individuals can be intermediate in these respects (Quick 1954; Kerney and Cameron 1979) and the systematics of the whole genus in western Europe is currently in some doubt (Preece 1992; Faulkner 1992; Gittenberger and Bakker 1992). *C. lubrica* is both common and widespread in the woodlands studied whereas *C. lubricella*, which prefers drier habitats than its congener, was encountered far less frequently and specimens which could be ascribed to the latter species with confidence were in fact found at only one site. Another species which may have been under-recorded for similar reasons is the slug *Arion silvaticus*, specimens of which have not always been easy to separate from other members of the *A. circumscriptus* aggregate (Davies 1977, 1979; Kerney and Cameron 1979).

## RESULTS

The Mollusca recorded in each of the woodlands are indicated in Table 3. In total 51 species were noted, the mean number of species per site being  $29.06 \pm 1.49$ , range 19 to 39. The frequency of occurrence of species varied greatly, thus eleven were found at all seventeen sites whilst three were located in just one woodland each. The number of sites at which each species was found is indicated in Table 4.

WARDHAUGH: THE TERRESTRIAL MOLLUSCAN FAUNA OF SOME WOODLANDS

TABLE 3

Species of terrestrial mollusc present in seventeen woodlands in North East England

Species	Site Number*																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Carychium minimum</i>	*			*		*		*				*	*	*	*	*	*
<i>Carychium tridentatum</i>	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
<i>Oxyloma pfeifferi</i>	*			*										*		*	
<i>Azeca goodalli</i>														*		*	
<i>Cochlicopa lubrica</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Cochlicopa lubricella</i>														*			
<i>Columella aspera</i>												*	*				*
<i>Columella edentula</i>				*								*	*	*	*	*	*
<i>Vertigo substriata</i>												*			*		
<i>Leiostyla anglica</i>								*	*		*	*		*		*	
<i>Lauria cylindracea</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Acanthinula aculeata</i>				*	*		*	*	*	*		*	*		*		*
<i>Spermodea lamellata</i>												*	*	*			*
<i>Punctum pygmaeum</i>			*	*		*				*		*	*	*	*		*
<i>Discus rotundatus</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Arion ater</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Arion subfuscus</i>	*	*	*		*	*		*	*		*	*		*	*	*	*
<i>Arion circumscriptus</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Arion silvaticus</i>					*	*		*			*	*		*	*		*
<i>Arion fasciatus</i>	*	*			*		*	*	*			*	*		*		
<i>Arion distinctus</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
<i>Arion intermedius</i>	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Vitrina pellucida</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Vitrea crystallina</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Vitrea contracta</i>							*			*		*	*	*		*	
<i>Nesovitrea hammonis</i>		*	*	*		*		*	*	*		*	*	*	*	*	*
<i>Aegopinella pura</i>	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Aegopinella nitidula</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Oxychilus cellarius</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Oxychilus alliarius</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Oxychilus helveticus</i>						*											
<i>Tandonia budapestensis</i>		*	*		*	*	*	*									*
<i>Boetgerilla pallens</i>					*											*	
<i>Limax maximus</i>	*	*	*	*	*	*	*	*	*		*	*		*	*		*
<i>Limax cinereoniger</i>												*					
<i>Limax marginatus</i>				*			*				*	*		*	*	*	*
<i>Derocereas laeve</i>	*			*				*	*			*	*	*	*	*	
<i>Deroceras reticulatum</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Deroceras caruanae</i>	*	*	*		*		*	*				*	*	*			
<i>Euconulus alderi</i>	*			*								*		*			
<i>Euconulus fulvus</i>	*		*	*	*	*	*	*	*		*	*	*	*	*	*	*
<i>Cochlodina laminata</i>			*											*	*	*	*
<i>Clausilia bidentata</i>			*	*								*	*	*	*	*	*
<i>Ashfordia granulata</i>				*										*		*	*
<i>Zenobiella subrufescens</i>															*	*	*
<i>Trichia striolata</i>		*	*	*	*	*		*									*
<i>Trichia hispida</i>	*		*	*		*	*	*	*			*	*	*	*	*	*
<i>Arianta arbustorum</i>			*	*					*			*	*	*	*	*	*
<i>Cepaea nemoralis</i>	*			*	*	*	*	*		*	*	*	*				*
<i>Cepaea hortensis</i>			*											*		*	*
<i>Helix aspersa</i>			*										*				
Total	26	20	29	32	26	27	25	30	25	19	22	39	32	39	32	34	37

\* See Table 1 for names and further details of the woodlands surveyed.

Nomenclature follows that of Kerney and Cameron (1979), except for two more recent taxonomic revisions: *Arion hortensis* from A and *Milax budapestensis* of these authors are here named *Arion distinctus* and *Tandonia budapestensis* respectively.

TABLE 4

Frequency of occurrence of terrestrial mollusc species in seventeen woodlands in North East England.

Species		(total)	Number of sites at which present	% of sites at which present
<i>C. lubrica</i>	<i>L. cylindracea</i>	(11)	17	100
<i>D. rotundatus</i>	<i>A. ater</i>			
<i>A. circumscriptus</i>	<i>V. pellucida</i>			
<i>V. crystallina</i>	<i>A. nitidula</i>			
<i>O. cellarius</i>	<i>O. alliarius</i>			
<i>D. reticulatum</i>				
<i>C. tridentatum</i>	<i>A. distinctus</i>	(4)	16	94.1
<i>A. intermedius</i>	<i>A. pura</i>			
<i>E. fulvus</i>		(1)	15	88.2
<i>L. maximus</i>		(1)	14	82.4
<i>A. subfuscus</i>	<i>N. hammonis</i>	(3)	13	76.5
<i>T. hispida</i>				
<i>C. nemoralis</i>		(1)	11	64.7
<i>C. minimum</i>	<i>A. aculeata</i>	(2)	10	58.8
<i>P. pygmaeum</i>	<i>A. fasciatus</i>	(5)	9	52.9
<i>D. laeve</i>	<i>D. caruanae</i>			
<i>A. arbustorum</i>				
<i>A. silvaticus</i>	<i>L. marginatus</i>	(3)	8	47.1
<i>C. bidentata</i>				
<i>C. endentula</i>	<i>T. budapestensis</i>	(3)	7	41.2
<i>T. striolata</i>				
<i>L. anglica</i>	<i>V. contracta</i>	(2)	6	35.3
<i>C. laminata</i>		(1)	5	29.4
<i>D. pfeifferi</i>	<i>S. lamellata</i>	(5)	4	23.5
<i>E. alderi</i>	<i>A. granulata</i>			
<i>C. hortensis</i>				
<i>C. aspera</i>	<i>Z. subrufescens</i>	(2)	3	17.7
<i>C. goodalli</i>	<i>V. substriata</i>	(4)	2	11.8
<i>B. pallens</i>	<i>H. aspersa</i>			
<i>C. lubricella</i>	<i>L. cinereoniger</i>	(3)	1	5.9
<i>D. helveticus</i>				

Among the less frequently recorded species, *Tandonia budapestensis*, *Deroceras caruanae*, *Trichia striolata* and *Helix aspersa* are all synanthropic and much more common in habitats other than woodlands in the study area, for example gardens, waste places and agricultural land. *H. aspersa* is also a common species of coastal sand dunes in the area. Thus the lesser frequency with which these species were recorded in woodlands should not be taken as representative of their regional status. To a lesser degree, the slug *Boetgerilla pallens* probably also falls into this category. It was first recorded in Britain in 1972 (Colville, Lloyd-Evans & Norris 1974) and seems to be expanding its range rapidly. To date however, there are only three records for this species in Cleveland, two being reported in this study.

The snail *Oxychilus helveticus* was found at only one sites, being close to the northern limit of its range in this region (Kerney 1976). There are two recent records of this species elsewhere in vice-county 66 and one in vice-county 62 (author's unpublished data). It was not recorded in Durham or Northumberland (vice-counties 66, 67 and 68) by Lowe (1989).



With reference to the physical factors noted in Table 1 there appears to be no obvious relations between species richness and altitude, predominant aspect of slope or drift geology. However, inspection of the data suggests that in general the more species rich woodlands are those which are larger, more moist, more easterly in location and of potentially ancient status. The number of species present is positively associated with the logarithm of woodland area (Figure 2. For the fitted regression line,  $b = 5.86 \pm 2.44$ ,  $t = 2.40$ ,  $p < 0.05$ ).

Table 5 lists the species located in this study in order of mean area of the woodlands in which they occurred. The number of woodlands considered is rather small for this type of analysis to be particularly accurate and the difficulty is compounded by the fact that some species occurred in very few woods. Further, the analysis would be improved by the inclusion of more larger woods of between 50 and 200 hectares in area. Nevertheless the results are of some interest, those species generally restricted to deciduous woodland as habitat occur mostly towards the upper end of the range for mean woodland area in Table 5. Kerney & Stubbs (1980) list a number of molluscs as being largely confined, in Britain, to woodlands of ancient semi-natural status. Five of these species were located in the present study. *Zenobiella subrufescens* and *Spermodea lamellata* occurred in larger woodlands (mean areas 86.7 and 65.5 ha. respectively) but *Leiostyla anglica* (mean area 24.9 ha.) falls in the middle of the range. Data for *Vertigo substriata* and *Limax cinereoniger* are too few to comment upon.

There is an expected association between species richness and moisture level (one sided Spearman rank correlation test:  $r = 0.502$ ,  $P < 0.05$ ). The means of assessing the latter (Table 2) was somewhat subjective and hence the data presented have their limitations but nevertheless, this simple method at least serves to demonstrate that the more moist woodlands do tend to be more species rich. As expected, wetland species such as *Carychium*

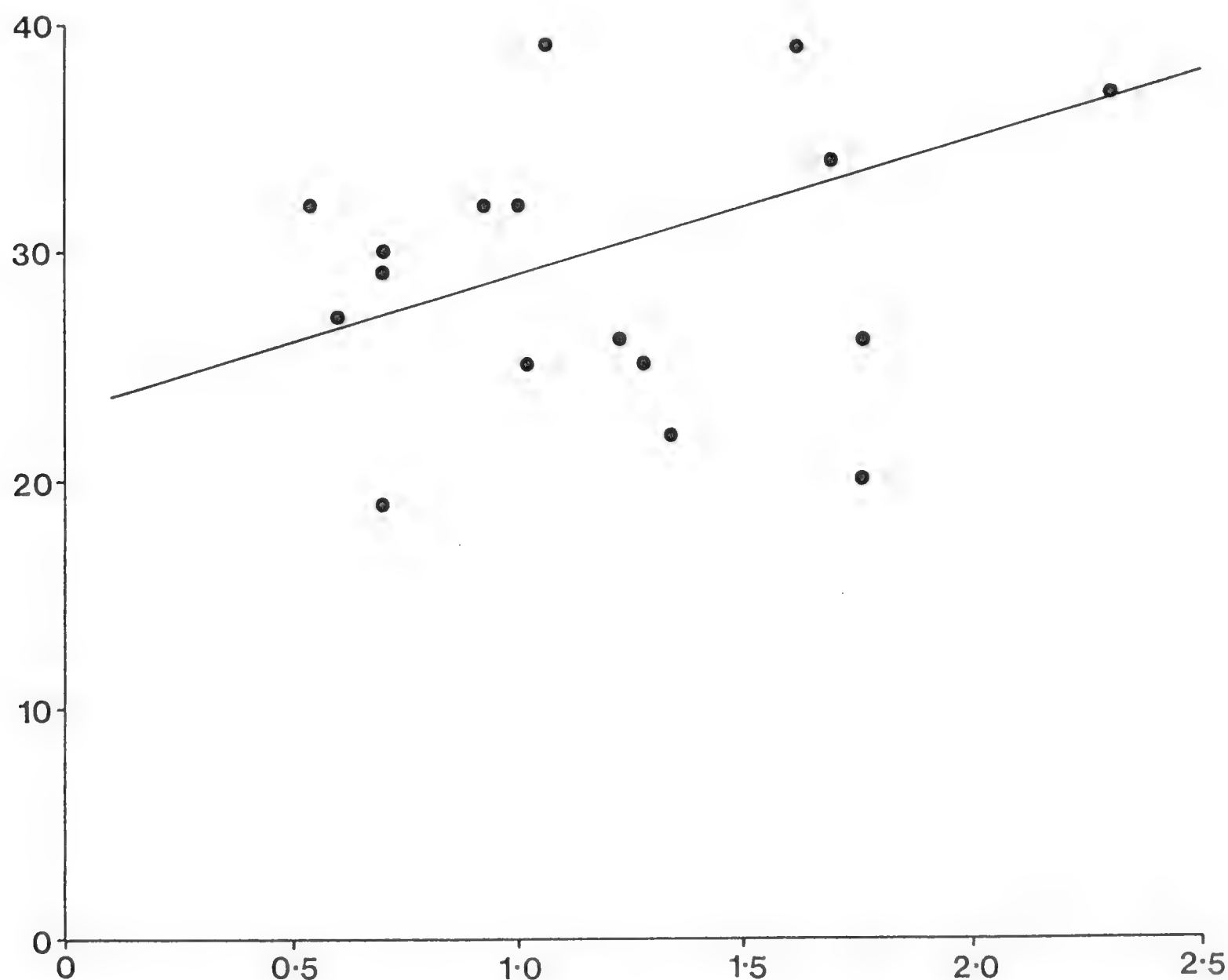


Fig. 2. Relationship between number of species and logarithm of the area of woodlands. For the fitted regression line,  $b = 5.86 \pm 2.44$   $t = 2.40$   $p < 0.05$ .

Vertical axis: Number of species.

Horizontal axis: Log area of woodland (ha.).

TABLE 5

Mean area of woodlands inhabited by terrestrial molluscs. Only those species with a mean value greater than that for all woods (= 24.5 ha.) are included

Species	Mean area (ha)	No. of woods in which present
<i>Z. subrufescens</i>	86.7	3
<i>C. aspera</i>	83.5	3
<i>C. hortensis</i>	66.6	4
<i>A. granulata</i>	66.3	4
<i>S. lamellata</i>	65.5	4
<i>C. laminata</i>	55.3	5
<i>C. edentula</i>	46.5	7
<i>L. marginatus</i>	43.7	8
<i>L. cinereoniger</i>	42.0	1
<i>C. bidentata</i>	41.3	8
<i>A. arbustorum</i>	38.9	9
<i>A. silvaticus</i>	37.0	8
<i>C. minimum</i>	35.2	10
<i>T. budapestensis</i>	32.5	7
<i>P. pygmaeum</i>	32.2	9
<i>T. striolata</i>	31.5	7
<i>A. goodalli</i>	30.8	2
<i>A. aculeata</i>	30.5	10
<i>A. subfuscus</i>	29.9	13
<i>T. hispida</i>	29.7	13
<i>C. nemoralis</i>	29.0	11
<i>N. hammonis</i>	28.1	13
<i>E. fulvus</i>	27.3	15
<i>V. substriata</i>	26.0	2
<i>A. intermedius</i>	25.9	16
<i>A. pura</i>	25.9	16
<i>B. pallens</i>	25.8	2
<i>C. tridentatum</i>	25.6	16
<i>A. distinctus</i>	25.4	16
<i>L. maximus</i>	25.2	14
<i>L. anglica</i>	24.9	6

*minimum*, *Oxyloma pfeifferi*, *Vertigo substriata*, *Deroceras laeve* and *Euconulus alderi* tended to occur only in woods with higher moisture scores.

The more easterly woodlands (sites 12 to 17) are significantly more species rich than those lying to the west (eastern group mean  $35.5 \pm 1.33$ , western group mean  $25.5 \pm 1.21$ ;  $t = 5.19$ ,  $P < 0.001$ ). Those woodlands listed as likely to be ancient (ie in continuous existence since at least 1600 AD) in the English Nature inventories of ancient woodland (Cooke 1987; Carter 1987a, 1987b) are just significantly more species rich than the remainder. The putative ancient woodlands are sites 3 and 10 to 17 inclusive (see Table 1), mean  $32.6 \pm 2.48$ ; other woodlands mean  $26.4 \pm 1.27$ ;  $t = 2.14$ ,  $P < 0.05$ .

Clearly, the four factors considered, namely woodland area, moisture level, east-west location and age are closely interlinked. More sophisticated statistical techniques would be required in order to assess the relative important of each. For this to be reliable a larger sample would be required, ideally including woodlands exhibiting less concurrence for the parameters in question. In addition, some means of estimating age of woodlands would be necessary, something which would be very difficult.

In order to analyse variation in molluscan species composition between woodlands, a number of statistical techniques have been used in the past. These include the Simple Matching Index (Cameron 1973), Maximum Similarity Index (Cameron 1978) and

Reciprocal Averaging Ordination (Tattersfield 1990). All of these techniques have both strengths and weaknesses, some of which are reviewed by Cook (1978). For the present study, Sorensen's coefficient ( $C_s$ ) was adopted ( $C_s = 2j/a+b$ , where  $j$  = number of species at both sites,  $a$  = number of species at site  $a$ ,  $b$  = number of species at site  $b$ ). It is a simple formula and therefore the basis upon which comparisons are made is easily visualised. It takes into account only joint presence of species (unlike some techniques, which include both joint presence and joint absence) and therefore for any species it would seem to assume no more than that the two sites in question provide a suitable (but not necessarily identical) suite of niche requirements.

$C_s$  values for all pairs of sites were calculated and these were reduced to a dendrogram (Figure 3) details of this technique being provided by Sokal & Sneath (1963). All values for  $C_s$  are high (0.82 to 0.89) but two clusters are apparent. As might be expected from the patterns outlined above, one includes predominantly western sites, characteristically smaller, probably secondary woodlands which are species poor (sites 1, 2, 5, 6, 7, 8, 9, and 11). The other group comprises chiefly eastern sites that are larger, likely to be ancient and more species rich (sites 4 and 12 to 17 inclusive). The second of these groups is significantly more species rich, the means being  $25.1 \pm 1.08$  and  $35.0 \pm 1.23$  respectively;  $t = 6.08$ ,  $P < 0.001$ .

Careful inspection of dendrogram suggests that the more species rich woodlands are more tightly clustered than the species poor ones. Thus, for the seven most species rich sites, the mean for all pairs of  $C_s$  values to  $80.86 \pm 0.860$ , compared with a mean of  $77.43 \pm 1.197$  for the seven most species poor woodlands. This difference is statistically significant ( $t = 2.327$ ,  $P < 0.05$ ).

It is well known (eg Boycott 1934), and demonstrated in the present study, that widespread and common molluscan species are not replaced by scarce ones in areas where

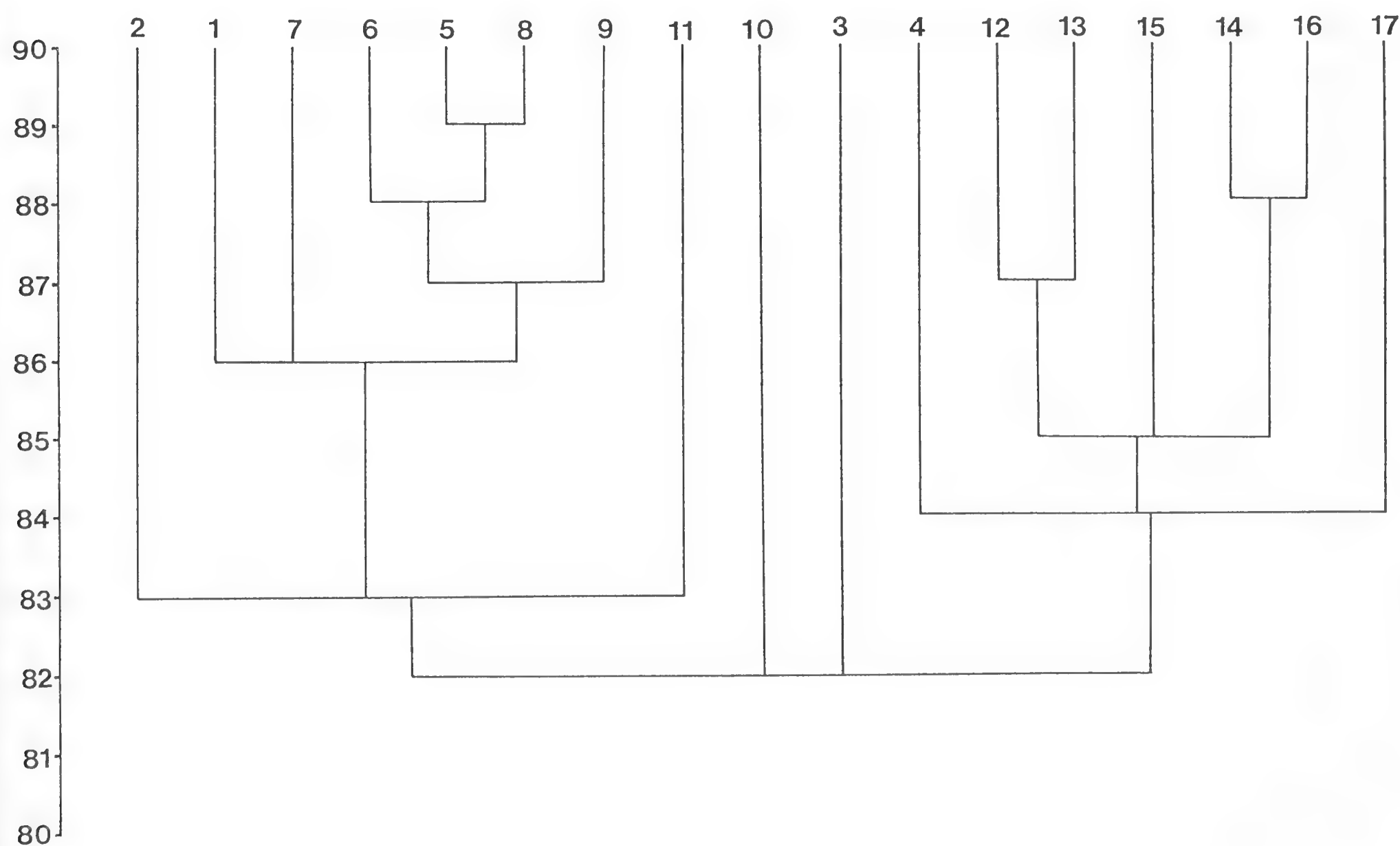


Fig. 3. Dendrogram indicating relationships between woodlands with respect to their molluscan fauna.

Vertical axis:  $C_s$ .

Horizontal axis: (at top of figure) Woodland number.



the latter occur. Hence it may tend to be the presence of certain scarce species which results in the overall richness of some woodlands. Table 6 lists the species recorded in this survey, in rank order, based upon the mean number of species present in those woods in which each was found to occur. It is of interest to note that the degree of correspondence between this list and that for woodland area (Table 5) is not great, however, four of the ancient woodland species listed by Kerney & Stubbs (1980) rank highly (*L. cinereoniger*, *S. lamellata*, *V. substriata* and *Z. subrufescens*) with a fifth (*L. anglica*) located toward the middle of the range.

DISCUSSION

The results described above indicate that species richness may be positively associated with woodland area, moisture level, east west location and age. However, because it is evident that at least some of these factors are in turn associated with one another, assessment of the extent to which each influences species richness directly is not easy. Consequently, even

TABLE 6

Mollusc species ranked in order of mean species number for the woodland in which they were found to occur. Only those species with a mean value greater than that for all woods (29.06) are included.

Species	Mean no. species per wood	No. of woods in which present
<i>C. lubricella</i>	39.00	1
<i>L. cinereoniger</i>	39.00	1
<i>S. lamellata</i>	36.75	4
<i>A. goodalli</i>	36.50	2
<i>V. substriata</i>	35.50	2
<i>A. granulata</i>	35.50	4
<i>C. edentula</i>	35.00	7
<i>C. hortensis</i>	34.75	4
<i>Z. subrufescens</i>	34.34	3
<i>C. bidentata</i>	34.25	8
<i>C. laminata</i>	34.20	5
<i>E. alderi</i>	34.00	4
<i>A. arbustorum</i>	33.22	9
<i>C. minimum</i>	32.80	10
<i>O. pfeifferi</i>	32.75	4
<i>C. aspera</i>	32.67	3
<i>L. marginatus</i>	32.50	8
<i>D. laeve</i>	32.11	9
<i>P. pygmaeum</i>	31.78	9
<i>L. anglica</i>	31.50	6
<i>A. silvaticus</i>	31.50	8
<i>V. contracta</i>	31.33	6
<i>T. hispida</i>	31.31	13
<i>H. aspersa</i>	30.50	2
<i>N. hammonis</i>	30.38	13
<i>E. fulvus</i>	30.34	15
<i>B. pallens</i>	30.00	2
<i>A. aculeata</i>	29.70	10
<i>C. tridentatum</i>	29.69	16
<i>A. subfuscus</i>	29.69	13
<i>A. intermedius</i>	29.63	16
<i>A. pura</i>	29.63	16
<i>D. caruanae</i>	29.56	9
<i>L. maximus</i>	29.21	14

where statistically significant relationships have been demonstrated, caution should be applied in their interpretation and, moreover, association does not necessarily imply a causal relationship.

Nevertheless, the patterns of association noted are much as might be expected, thus species area relationships for both plants and animals are well known, Lloyd-Evans (1975) having demonstrated a very close correlation indeed between logarithms of area and numbers of mollusc species in Yorkshire. This involved extensive analysis based on land areas ranging from 4 to 314900 square kilometres and was thus unlike the present study which dealt with specific habitat type. In the latter, the relationship is statistically significant but much less close (Figure 2). There may be several contributing factors to this widespread phenomenon, these being reviewed by Cockburn (1991). Larger woodlands may include more microhabitats and therefore provide additional niches as a result of increased structural and biological diversity. Although a number of studies, noted in the introduction above, have been carried out on woodland molluscs in the British Isles, in none of these were species area relationships considered, nor is any data on woodland area provided. This is unfortunate since it precludes comparison with the present work.

With regard to the association between species richness and moisture level, in a study of woodland mollusc assemblages in southern Sweden, Wäreborn (1969) noted a correlation between moisture and abundance of terrestrial molluscs, the salient factor being relative humidity, which was found to be high in shaded areas even if soil moisture levels were low. In the present study, most of the easterly woodlands are situated in steep sided, narrow valleys occupied by streams, sites known as gills, where shading may well be significant (part or all of sites 4, 5, 6 and 12 to 17 inclusive fall into this category). Due to their steepness, these woodlands are also well drained, at least in part. Paul (1978a) concluded that in Hayley Wood, Cambridgeshire, drainage was possibly the main factor controlling mollusc distribution. The soils of the steeper slopes have higher pH levels, perhaps because they are better drained, these areas being more species rich. Several studies have provided evidence for a link between soil pH and species richness in terrestrial molluscs (Cameron & Redfern 1972, Cameron 1973, Bishop 1976) however Wäreborn (1969) found that soil pH can vary by up to 1.0 even in seemingly uniform habitats and that it can vary with depth and season. The present study was a wide ranging survey involving woodlands which are all to a greater or lesser extent heterogeneous in nature and hence measurement of factors such as soil pH were purposefully not made since it was felt that they would be meaningless in a whole woodland situation.

Concerning the observation that the more easterly woodlands were found to be more species rich than those in the west, the underlying factor may be climatic, the former perhaps being subject to a greater maritime influence. In a broadly similar investigation, Tattersfield (1990) noted an east to west trend in species composition in the calcareous White Peak woodlands of the south Pennines. This was ascribed to climatic differences, the more westerly woodlands being subject to a more atlantic climate, with the slug *L. cinereoniger* occurring more frequently. In the present study, a number of species were confined to eastern woodlands (Table 3), including *S. lamellata*, *L. cinereoniger*, *Z. subrufescens* and to a slightly lesser extent *L. anglica*. All are known from other sites close to the north east Yorkshire coast (authors unpublished data), having otherwise a somewhat westerly or north westerly distribution in the British Isles (Kerney 1976). Due to the steep sided nature of many of the eastern gills, they are likely to have their own microclimate, being more sheltered than adjacent areas. Consequently, existing meteorological data is not likely to be particularly reliable in attempting to pursue the above distribution pattern further. Instead, it would be necessary to make specific measurements of climate at the sites concerned.

As noted above, there is a fairly close concurrence between east west distribution of the woodlands and their age (Table 1). All of the eastern woodlands (sites 12 to 17 inclusive) are

deemed to be ancient, along with sites 3, 10 and 11 from the western group (Cooke 1987; Carter 1987a, 1987b). Assessment of the relative importance of these two parameters in determining species richness is not therefore easy. Concerning woodland age, it is important to bear in mind that from a conservative viewpoint identification of possibly ancient woodlands is not so much of value *per se* but because it indicates those sites which, as a result, might be of high biodiversity. The latter however depends upon more than age, notably perhaps the degree of disturbance to which the woodland has been subjected during its history, something which can take many forms. Thus in the present study the six easternmost sites, are likely to be both ancient and relatively undisturbed because being steep sided gills would render them unsuitable for timber extraction in the past. Mulgrave Wood (site 17) is a partial exception. Some areas have been landscaped in former times and others are currently in use for commercial timber production. Nevertheless, this is a large woodland complex in which there are some relatively undisturbed tracts. In contrast, the three putative ancient sites in the western group all show signs of a good deal of disturbance. Site 3 (Bassleton Wood) was part felled in the past and planted with conifers, although these have now been removed. Sites 10 (Cliff Ridge Wood) and 11 (Newton Wood) were used for sheep grazing until recently. The former has been extensively damaged in the past by mineral extraction and is also very dry. Of these three sites, Bassleton Wood has 29 species of which *C. laminata* is the most notable. Lloyd-Evans (1981) stated that this species is locally distributed in Yorkshire, preferring old deciduous woodland on base rich soils. Only 22 species were recorded in Newton Wood but one was *L. anglica*, perhaps an indication of its ancient status. Finally, in Cliff Ridge Wood just 19 species were recorded, none being of note. These facts perhaps serve to explain why the eastern woods are much more species rich than the western group, and also why the difference in species richness between the putative ancient and recent woodlands, noted in the results above, is much less great. In the White Peak woods of the South Pennines. Tattersfield (1990) found no significant differences in the molluscan fauna of ancient and recent sites. In studies of the terrestrial molluscan faunas of the Malham area (Cameron & Redfern 1972) and the South Downs (Cameron 1973), it was found that the most species rich sites were those with high soil pH and minimal disturbances. In the light of the above, it is of interest to note that in the dendrogram (Figure 3), Newton Wood (site 11) is linked with the western, species poor group but sites 3 and 10 are not associated with either cluster. The only apparent anomaly in the clustering is the association of site 4 (Brewsdale) with the eastern group. Thirty two species were recorded in the wood, making it a relatively rich site, in part a consequence of its dampness and the presence of a number of wetland molluscs. However none of the old woodland indicator species listed by Kerney & Stubbs (1990) were located.

It was pointed out in the results section that in the dendrogram (Figure 3), the species rich sites are more tightly clustered than the species poor ones. The latter seem to be mainly secondary woodlands and this effect may result from chance colonisation and extinction events producing more disparate faunas. In contrast, the predominantly older, species rich sites may exhibit closer similarities because their species assemblages may tend to converge towards the same regional climax.

Overall, it seems that the factors controlling species richness in the terrestrial molluscan assemblages of the woodlands investigated are highly interdependent. More significantly, they probably operate on a much more localised scale than a whole woodland situation, especially if particular species are considered. In order to investigate further the reasons for differences in species composition between woodlands, the study of smaller, more homogeneous areas within each would be required. The correlation between distribution and abundance of molluscs and available leaf litter calcium noted by Wäreborn (1969) and similar work by Bishop (1977) are good examples of potentially fruitful approaches. In addition, biotic factors need to be considered. Studies carried out by Mordan (1977) on the



snails *Aegopinella nitidula*, *A. pura* and *Nesovitrea hammonis* revealed interesting effects on distribution resulting from predator prey interactions between these three species. The present study did however have rather different and more broadly based aims, principally to determine in the first instance what species do occur in the woodlands in question and to identify any broad patterns in species richness. As a result of the work carried out some general predictions are possible. Thus, for example, should any additional woodlands in the area be investigated, then one might predict that seemingly older, undisturbed and moist sites are likely to contain about 35 species of terrestrial mollusca. Those with the opposite characteristics are likely to have 25 or fewer species. For the former, tentative predictions about the additional species which may be present and which contribute to their richness, can be made on the basis of Table 6. In order to evaluate further the relative influence of some of the factors considered, it may be possible to investigate old woodlands in the west of the region and any secondary ones to the east.

Comparison with other recent studies indicates that the woodlands of north east Yorkshire have a relatively rich molluscan fauna (Table 7). Indeed, if the present work were extended in the future to include other nearby woodlands, for which only incomplete data exist at present, then the total number of mollusc species recorded would increase from 51 to near 60 ie. about half of the British fauna; a high proportion for the land area involved.

In order to compare the present work with other investigations, Sorenson's coefficients have been calculated for the total number of species recorded in each study (Table 7). From this it can be seen that of other published works, the woodlands of north east Yorkshire are most similar to those of the Peak District, investigated by Tattersfield (1990). In the latter, two groups of woodlands were surveyed; the White Peak (calcareous) and Dark Peak (non-calcareous) woods. As might be expected, these are somewhat different from one another in

TABLE 7

## Terrestrial molluscs of woodlands in the British Isles

Author	No. of woods (type)	Location	Total no. of species	Range of species no. per wood	Cs in com- parison with present study
Present study	17 (non- calcareous)	N.E. Yorks & Durham	51	19-39	—
Tattersfield (1990)	21 (calcareous)	Peak District, S. Pennines	44	23-35	0.84
Tattersfield (1990)	17 (non- calcareous)	Peak District, S. Pennines	44	4-35	0.84
Paul <sup>a</sup> (1978b)	14 (mixed)	Cambridge	40	13-31	0.81
Bishop (1976)	7 <sup>b</sup> (mixed)	Somerset	42	6-24	0.77
Bishop (1977)	11 (non- calcareous)	S.W. Ireland	42	10-26	0.77
Cameron & Redfern (1972)	14 (calcareous)	Malham Pennines	41	7-34	0.76
Cameron (1973)	44 <sup>c</sup> (calcareous)	South Downs	43	7-27	0.70

a = Author considers that not all the site lists are definitive since some woods were only visited only once.

b = 7 sites of 1,000 square meters rather than entire woods.

c = 44 sites of 1,000 square meters rather than entire woods.

their molluscan assemblages ( $C_s = 0.80$ ) and interestingly, the present study indicates that the north east Yorkshire woodlands are equally similar to both ( $C_s = 0.84$  in both cases). Differences in species assemblages between the Peak District woods as a whole and those of the present study can be accounted for to some extent by differences in geographical range of individual species. Thus, *Succinea putris*, *Vertigo pusilla*, *Ena obscura*, *Arion flagellus*, *Zonitoides nitidus*, *Z. excavatus*, *Limax tenellus* and *Helicigona lapicida* were recorded in the Peak District woods and most of these are probably scarce in the part of north east Yorkshire investigated, with the last two species possibly absent altogether. Only one species, *E. obscura* is known from a number of other sites in north east Yorkshire. Conversely, *Oxyloma pfeifferi*, *Spermodea lamellata*, *Boetgerilla pallens*, *Deroceras caruanae*, *Ashfordia granulata* and *Helix aspersa* were recorded in the present study but not in the Peak District. Probably only *S. lamellata* has a geographical range which does not include the latter.

Similar comparisons can be made with the other studies listed in Table 7 and likewise, differences in geographical distribution account for some, but by no means all of the differences in species assemblages.

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# WARDHAUGH: THE TERRESTRIAL MOLLUSCAN FAUNA OF SOME WOODLANDS

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# A NEW *AMPHITHALAMUS* CARPENTER, 1864 SPECIES (GASTROPODA, RISSOIDEA, BARLEEIDAE) FROM THE BRAZILIAN COAST

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(Accepted for publication, 22nd April, 1995)

**Abstract:** *Amphithalamus glabrus*, a new species of Barleeidae, is described from the coast of São Paulo State, and is the first record of this family in the region.

**Key words:** *Amphithalamus*, Rissoidea, Brazil.

## INTRODUCTION

The genus *Amphithalamus* Carpenter, 1864 (type species *A. inclusus* Carpenter, 1864), Barleeidae – Anabathrinae, was hitherto unknown from the Brazilian coast. *Amphithalamus vallei* Aguayo & Jaume, 1947 was, however, found on the Brazilian oceanic islands of Abrolhos and Atol das Rocas (Leal, 1991).

In studies on the associated fauna of the coral *Mussismilia hispida* (Verrill), in progress by João Miguel M. Nogueira (doctoral thesis), some specimens belonging to the genus *Amphithalamus* were found. Analysis of the shell characters suggested these specimens were of an undescribed species.

Anatomical data on Barleeidae, and in particular on *Amphithalamus*, are scant. Ponder (1983) reviewed the Barleeidae at the generic level, and some anatomical data on *Amphithalamus incidatus* (Frauenfeld) and *A. vallei* Aguayo & Jaume were described. A full historical review on *Amphithalamus* in Western Atlantic waters is given by Rolan, (1991).

## MATERIAL AND METHODS

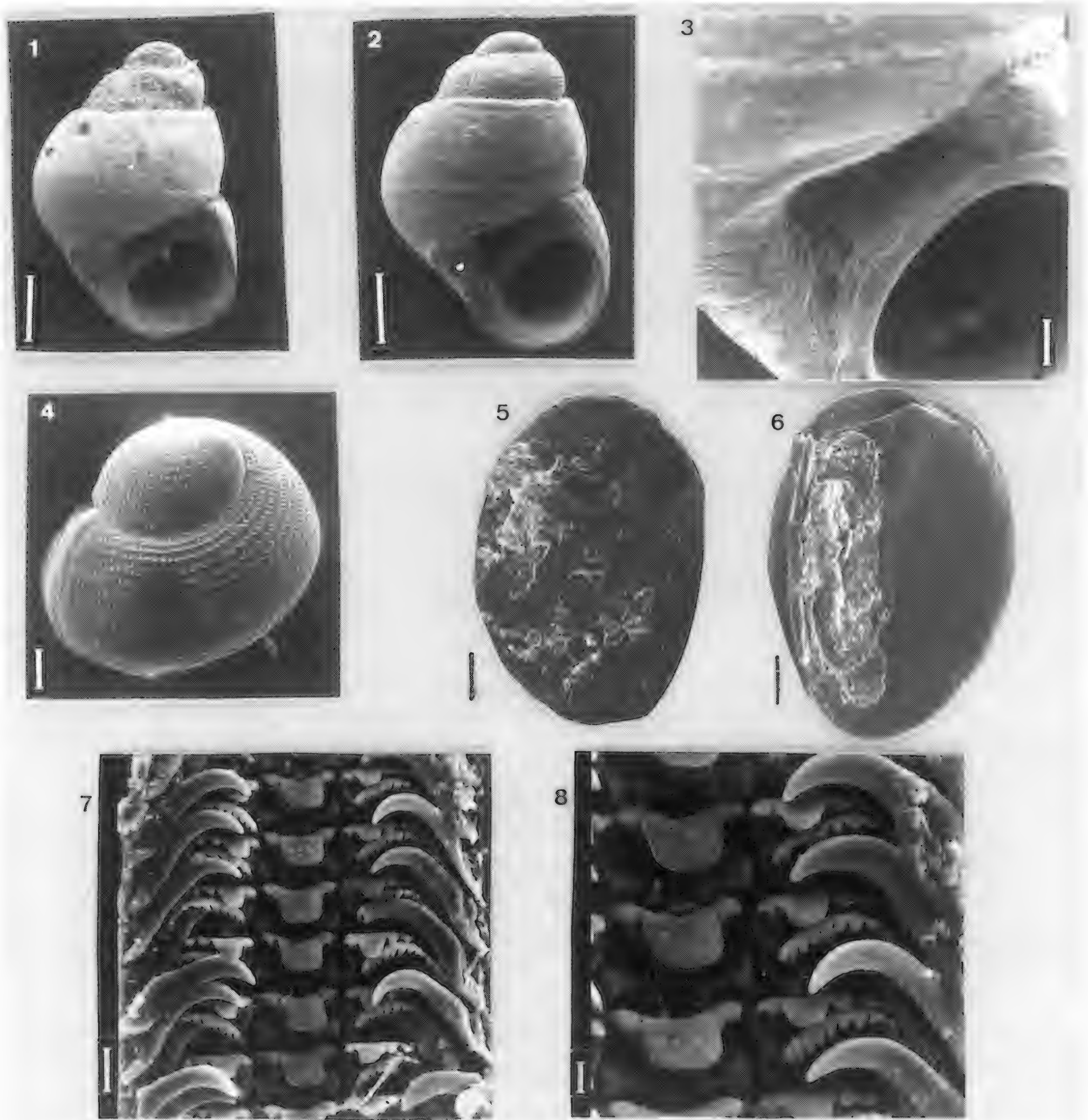
The specimens were collected by scuba-diving, and fixed in 4% formalin, subsequently preserved in 70% ethanol and deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP) collection.

Two females, studied anatomically, had their shells decalcified in Railliet-Henry fluid, another five specimens, two of them were males, had the head-foot extracted by means of a small hole pierced in the body whorl of the shell. They were then dehydrated in ethanol series, stained in carmine, cleared and fixed in creosote. Serial sections of two specimens were obtained by standard technique, stained by haematoxylin and eosin. Shell, radula and operculum were examined with SEM in the Laboratório de Microscopia Eletrônica do Instituto de Biociências da USP, using the technique of Solem (1970, 1972). All drawings were made with a camera lucida. The systematics and terminology are based on Ponder (1983).

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SYSTEMATICS

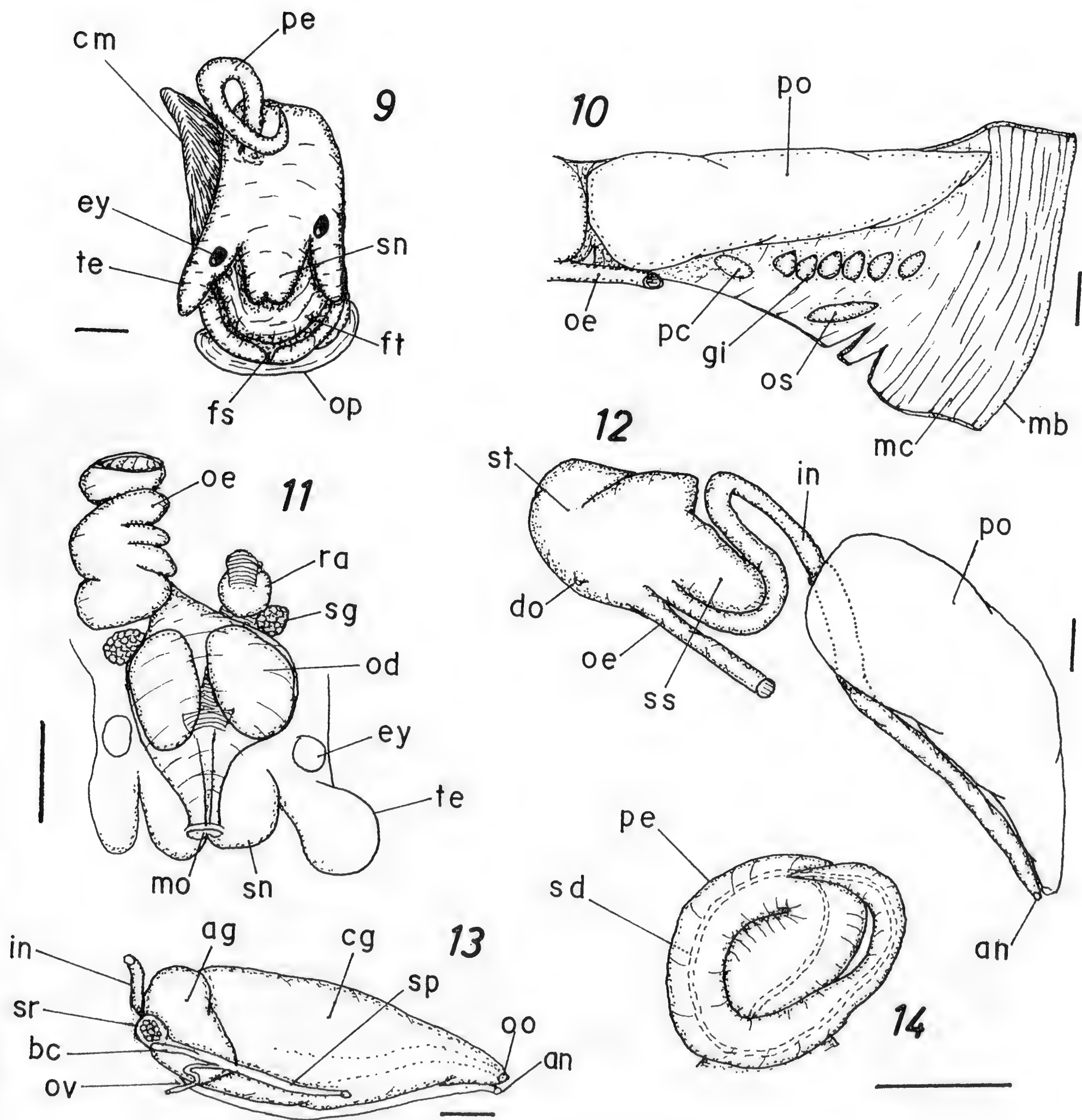
*Amphithalamus glabrus* new species  
(Figs. 1–15)



Figs. 1 to 8: *Amphithalamus glabrus* n.sp, SEM photos: 1) frontal view of a paratype shell, specimen with periostracum, scale = 200  $\mu\text{m}$ ; 2) the same for a specimen with removed periostracum, scale = 200  $\mu\text{m}$ ; 3) detail of the umbilical region of the same, scale = 50  $\mu\text{m}$ ; 4) protoconch, scale = 50  $\mu\text{m}$ ; 5) outer view of the operculum, scale = 50  $\mu\text{m}$ ; 6) inner view of the same, scale = 50  $\mu\text{m}$ ; 7) radular teeth, scale = 5  $\mu\text{m}$ ; 8) the same, scale = 2  $\mu\text{m}$ .

*Types:* Holotype: MZUSP 28997. Paratypes: MZUSP 27998, 1 specimen; MZUSP 27999, 5 specimens, all from the type locality; MZUSP 28000, 1 specimen, São Paulo, Ubatuba, Mar Virado Island; MZUSP 28001, 1 juvenile specimen, São Paulo, Ubatuba, Palmas Island;





Figs. 9 to 14: *Amphithalamus glabrus* n.sp., anatomical drawings: 9) head-foot of a male, penis partially uncoiled; 10) pallial organs of a female, inner view; 11) anterior region of the digestive system, ventral view; 12) digestive system, ventral-right view; 13) pallial oviduct, ventral-right view (anterior side at right); 14) penis in dorsal view. Scales = 0.1 mm. Abbreviations: ag, albumen gland; an, anus; bc, bursa copulatrix; cg, capsule gland; cm, columellar muscle; do, digestive gland cut; ey, eyes; fs, foot slit; ft, foot; gi, gill; in, intestine; mb, mantle border; mc, mantle collar; mo, mouth; od, odontophore; oe, oesophagus; oo, oviducal opening; op, operculum; os, osphradium; ov, oviduct; pc, pericardium; pe, penis; po, pallial oviduct (scheme); ra, radular nucleus; sd, sperm duct; sg, salivary gland; sn, snout; sp, spermathecal duct; sr, seminal receptacle; ss, style sac; st, stomach; te, tentacle.

MZUSP 28002, 2 specimens, São Paulo, Ubatuba, Mar Virado Island. MZUSP 28003, 2 specimens, São Sebastião, Vitória Island, Professora Bay.

*Type locality:* Brazil, São Paulo State, São Sebastião city, Vitória Island, 23°45'S 45°01'W.

*Diagnosis:* Shell with rounded body whorl, without carina or perisutural sculpture, small aperture, low spire, suture rather shallow. Operculum thickened around insertion region.

Oesophagus entering stomach close to exist of intestine, style sac without style. Penis with long-slender tip. Pallial oviduct long and sharp anteriorly.

*Description:* Shell (figs. 1–4): very small (to 1.2 mm), ovate-conic, pale-brown in colour, somewhat transparent. Protoconch (fig. 4) dome-shaped, about 1.25 whorls; sculptured by spiral rows of minute pits. Teleoconch up to two convex whorls, with obsolete growth lines and spiral lines; a low median spiral ridge is found at the beginning of the body whorl (figs. 1, 2). Periostracum thick, velveted (fig. 1), yellowish. Suture rather shallow. Aperture rounded and proportionally small, outer lip orthocline, Umbilical region with low-spiral folds between inner lip and parietal wall; a callus in superior region, near to suture (fig. 3).

Inner chitinous layer very conspicuous when the shell is decalcified, glossy, pale-brown in colour.

Head-foot (fig. 9): Snout short, bilobed. Cephalic tentacles rather long, paddle-shaped, inconspicuously ciliated. Dark eyes at outer tentacles bases, not bulged. Foot short, simple, with posterior mucous gland opening by a longitudinal slit reaching to posterior end. Anterior mucous gland present. Basic colour pale-yellow with dark pigment posteriorly to the eyes.

Operculum (figs. 5, 6): corneus, elliptical, pseudoconcentric, eccentric nucleus, without pegs (fig. 5), transparent-yellowish, conspicuously double-layered. Occupies all aperture. Thickened at its insertion region (fig. 6).

Pallial cavity (fig. 10): about one whorl in length. Mantle border simple, without tentacles nor siphon; broad and thin mantle collar. Gill transversal, with six finger-shaped filaments. Osphradium elliptic, rather long, about a half of the gill length.

Digestive system: oral tube conspicuous, without jaws (fig. 11). Odontophore with a pair of elliptical cartilages. Radula (figs 7, 8): rachidian 1.1/2, with a broad, blunt medium cusp and small, sharp lateral cusps; a pair of small denticles near outer edge; weakly thickened lateral margins at about 45°; ventral margin of rachidian with tongue-like extension. Lateral teeth 1+1+2, primary cusp blunt. Inner marginal teeth simple, curved, with 10 small, rather regular cusps. Outer marginal teeth simple, curved, outer margin smooth, inner margin with about 5 small cusps (fig. 7, bottom-right). A pair of small salivary vesicles just posterior to the odontophore (fig. 11). Oesophagus with some glandular folds in its anterior portion (fig. 11), and simple, without pouches nor special glands in its posterior portion (fig. 12). Stomach spacious (fig. 12), rather long, style sac (about equal in length to the remainder of the stomach) no crystalline style could be found; single digestive gland opening. Intestine narrow, originates near the oesophagic insertion, has typical features (fig. 12). Rectum, runs above and behind the posterior edge of the pallial oviduct (of females), then emerges from the left and runs alongside the pallial oviduct to the anus (fig. 12).

Genital system:

Male: testis (viewed through the shell) not distinctly lobate. Penis (figs. 9, 14) proportionally small and coiled, far back in the head, discretely at right; penis approximately the same length as the pallial cavity when straightened (fig. 9). Penial duct closed simple, non-undulating, near the outer surface of the penis. Penial opening situated at the pointed, distal end of the penis, which is conspicuously slender (fig. 14).

Female: pallial oviduct long (fig. 13). Albumen gland short; capsule gland long (about  $\frac{3}{4}$  of total length of the pallial oviduct) and sharply pointed anteriorly, which has the oviduct opening at its tip. Seminal receptacle short and rounded. Bursa copulatrix slender and about the same length of seminal receptacle. Spermathecal tube short with opening to the pallial cavity (fig. 13).

*Habitat:* the specimens studied were found crawling on coral *Mussismilia hispida*, in about 5 m water depth.

*Range:* Brazil, São Paulo State, from Ubatuba to São Sebastião, infratidal.

*Measurements:* (respectively length and width) MZUSP 27997 (holotype) 0.8 by 0.5 mm; MZUSP 27999 (2 paratypes) 0.8 by 0.6 and 0.9 by 0.6.

*Etymology:* the specific name refers to almost smooth (*glabra*) surface of the shell, which lacks well developed carina or sculpture.

## DISCUSSION

*Amphithalamus glabrus* differs from *A. vallei* (Leal, 1991) in having a shallower suture, taller spire, aperture smaller and in lacking spiral carina.

The operculum of *A. glabrus* differs from those of other congeneric species (Ponder 1983; Rolán 1991) in having the insertion region thickened (fig. 6), in the other species this region is a depressed scar. The low spire, the less dense protoconch sculpture, the absence of subsutural striae, and the head-foot color pattern, also separate *A. glabrus* from the four Cubanian *Amphithalamus* species (Rolán 1991).

The stomach of *A. glabrus* is similar to that of *A. incidatus* (Ponder 1983), but the insertion of the oesophagus is closer to the intestine origin, and the style sac is longer. No jaws and style (within style sac) could be found in *A. glabrus*.

The penis of *A. glabrus* has the slender tip, longer than that of *A. incidatus* (Ponder 1983) whereas the pallial oviduct has a shorter and more rounded seminal receptacle and a sharper anterior region (Ponder 1983).

## ACKNOWLEDGMENTS

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# *XEROSECTA GIUSTII* A NEW HYGROMIID FROM TUSCANY (ITALY) CLOSE TO EXTINCTION (GASTROPODA, PULMONATA: HELICOIDEA)

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**Abstract:** *Xerosecta giustii* n. sp. is described from one locality in the Colline Metallifere (southern Tuscany, Italy). The new species is easily distinguished from all the other species of *Xerosecta*, both conchologically by virtue of its medium-sized, subglobose to depressed, robust shell, usually opaque, waxen, uniformly grey to whitish-grey in colour, and anatomically by genitalia as in *Xerosecta* species, but with a voluminous genital atrium containing a large, crest-like structure. The new species has only been found in the type locality and, at present, no other species endemic to Tuscany is known to have such a reduced distribution. This population did not seem to be threatened by human activity. Live snails, however, can no longer be found. A long drought in the winter of 1992–93 and the spring of 1993 and ploughing of part of the site might be responsible for disappearance of the population.

**Key Words:** *Xerosecta giustii* n. sp.; Hygromiidae; Italy; nomenclature, taxonomy, systematics, conservation.

## INTRODUCTION

*Xerosecta* is a genus of the xerophilous hygromiids living in the western Mediterranean. Apart from the two well known species, *X.* (s.str.) *cespitum* (Draparnaud, 1801) and *X.* (s.str.) *explanata* (Müller, 1774), an uncertain number of *Xerosecta* species, usually assigned to the obsolete or improper genus-group taxa *Jacosta* and *Xeromagna*, live in Spain and in Maghrebian North Africa (Hesse, 1934; Ortiz de Zarate, 1950; Alonso, 1975; Aparicio, 1982).

Only two species are found in mainland Italy: *X.* (s.str.) *cespitum*, in Piedmont, Liguria and Tuscany and *X.* (*Polloneriella*) *contermina* (Pfeiffer, 1847), in dune habitats along the central Tyrrhenian coast (Tuscany, Latium) (Alzona, 1971) (Fig. 30). Falkner (1990) regarded the Italian populations of *X. cespitum* as belonging to a distinct species, *X. introducta* (Schmidt, 1855). However, this opinion was completely unfounded, as not a single conchological or anatomical character distinguishes them from the French *X. cespitum*.

During a faunistic survey in the framework of research on the distribution of land snails in southern Tuscany we happened to find a xerophilous hygromiid with a large, depressed and umbilicated shell recalling that of some forms of *Cernuella* (s.str.) *virgata* (Da Costa, 1778) and even more *Cernuella* (*Xerocincta*) *neglecta* (Draparnaud, 1801); two species very frequent in the area.

Anatomical study immediately revealed that this snail had nothing to do with *Cernuella* but belonged to *Xerosecta* (s.str.). The peculiar shell and some of its anatomical features differentiate it from all the congeneric species, the shell and anatomy of which have been described up to now, and justify the description of a new species.

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## MATERIAL AND METHODS

Whole shells were photographed under the optical microscope (Wild M5A). All dimensions (shell height, maximum shell diameter, aperture height and aperture diameter) were measured with calipers.

Living specimens were drowned in water, then fixed and preserved in 75% ethanol, buffered with  $\text{CaCO}_2$ . Bodies were isolated after crushing the shell, and dissected under the optical microscope (Wild M5A) using thin, pointed, watchmaker's forceps. Anatomical details were drawn using a Wild camera lucida. Dimensions of anatomical tracts were measured using a millimetric lens set on the same Wild M5A microscope.

Radulae were manually extracted from buccal bulbs, washed in pure 75% ethanol, mounted on copper blocks with electronconductive glue, sputter-coated with gold and photographed using a Philips 505 SEM.

The material examined is listed as follows: site of collection, municipality and province names in parentheses, UTM reference, collector(s), date, number of specimens in parenthesis. Locality names and UTM references according to the official map of Italy (sheets of the series 1:25,000 M 891 or the series 1:100,000 M 681).

Explanation of symbols in Figs. 6–29: A anus, AG albumen gland, AP annular pad, BC bursa copulatrix, BF basal fenestration, BP basal pilaster, BW body wall, CGA crest-like structure of genital atrium, CM columellar muscle, DBC duct of bursa copulatrix, DG digitiform glands, DP distal penis, DSC dart sac complex, DSO dart sac opening, E epiphallus, ED ejaculatory duct, F flagellum, FHD first hermaphrodite duct, FO free oviduct, G glans or penial papilla, GA genital atrium, LDL left dorsal lobe, LLL left lateral lobe, P penis, PN pneumostoma, POS prostatic ovispermiduct, PP proximal penis, PR penial retractor muscle. PW penial wall, RDL right dorsal lobe, RGA retractor muscle of body wall near genital atrium, RLL right lateral lobe, SL subpneumostal lobe, T talon, UOS uterine ovispermiduct, V vagina, VD vas deferens

***Xerosecta (s.str.) giustii n.sp.***

[Figs. 1–19]

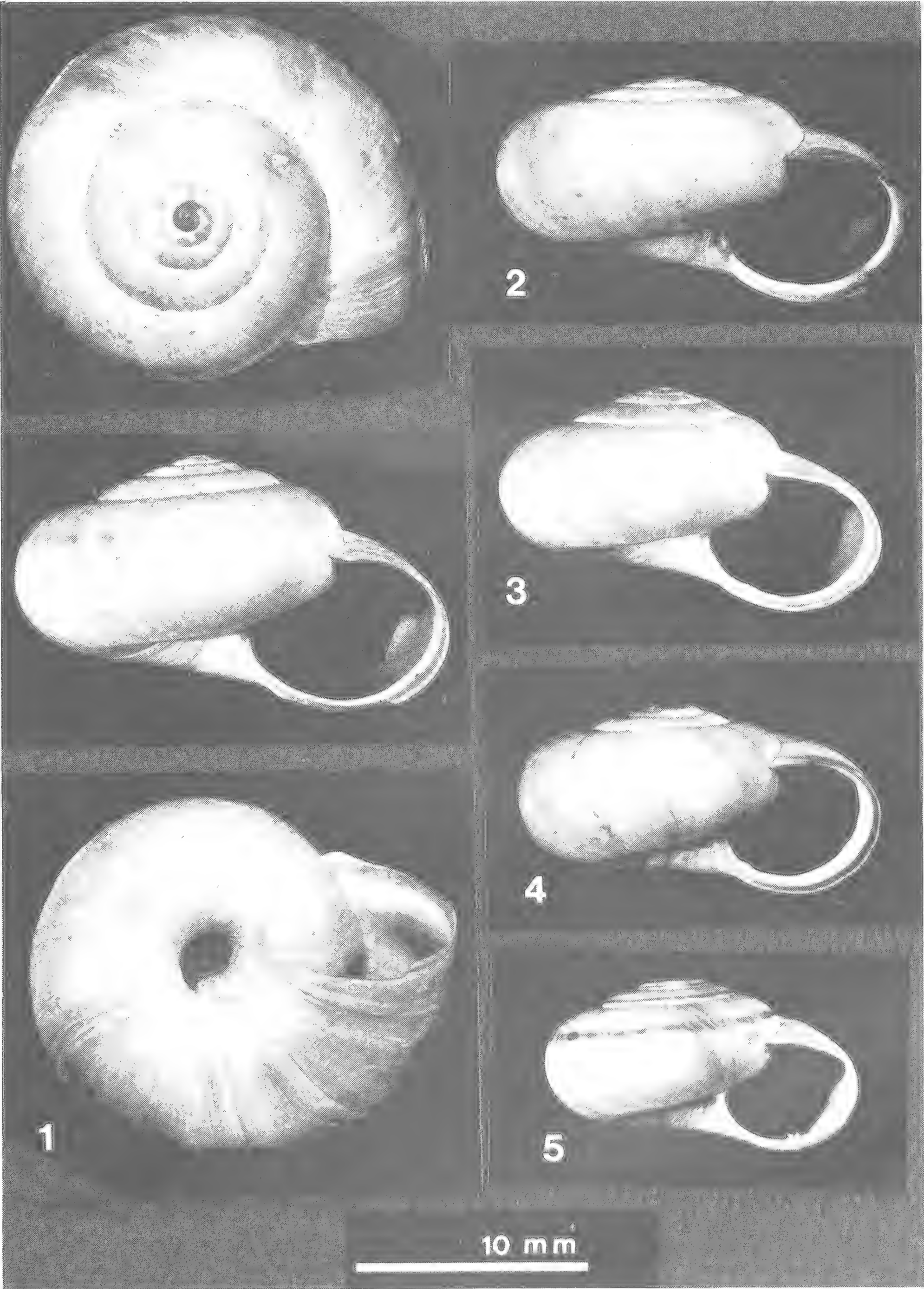
*Type series:* Holotype (Fig. 1) from Boccheggiano (Boccheggiano, Grosseto), 32TPN67, G.M. leg. 16.2.91, in the malacological collection of the Museo di Zoologia dell'Università di Firenze (MZUF no. 6734).

169 paratypes (163 shells + 6 alcohol specimens) from Boccheggiano (Boccheggiano, Grosseto), 32TPN67, G.M. leg. 16.2.91, G.M. leg. 25.8.91, G.M. & L.F. 30.5.92, in the Giusti Collection, Dipartimento di Biologia Evolutiva, Università di Siena, Via Mattioli 4; I-53100 Siena, Italy. Four paratypes in the malacological collection of the Museo di Zoologia dell'Università di Firenze (MZUF no. 6610); three paratypes in Senckenberg, Museum Forschungsinstitut (Frankfurt, Germany) (SMF 310426/3); three paratypes in Nationaal Natuurhistorisch Museum (Leiden, The Netherlands) (NNM 56909); three in M. Bodon collection (Genoa, Italy); one in S. Cianfanelli collection no. 4375/751 (Florence, Italy); one in E. Talenti collection (Florence, Italy).

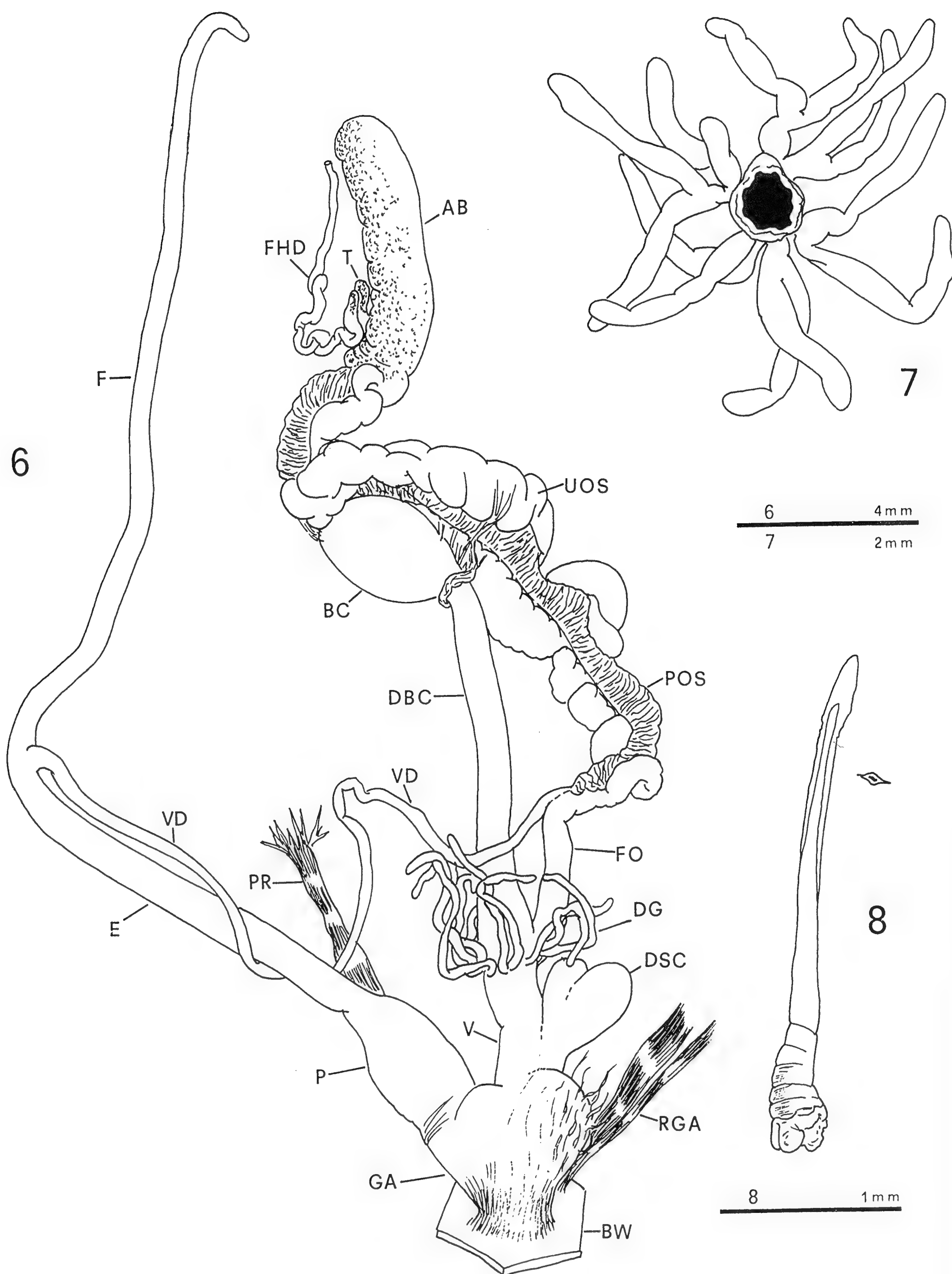
*Type locality:* Boccheggiano (Boccheggiano, Grosseto, Italy), 32TPN67.

*Diagnosis:* The new species is easily distinguished from all the other species of *Xerosecta*, both conchologically by virtue of its medium-sized, subglobose to depressed, robust shell, usually opaque, waxy, uniformly grey to whitish-grey in colour, and anatomically by genitalia as in *Xerosecta* species, but with a voluminous genital atrium containing a large, crest-like structure.

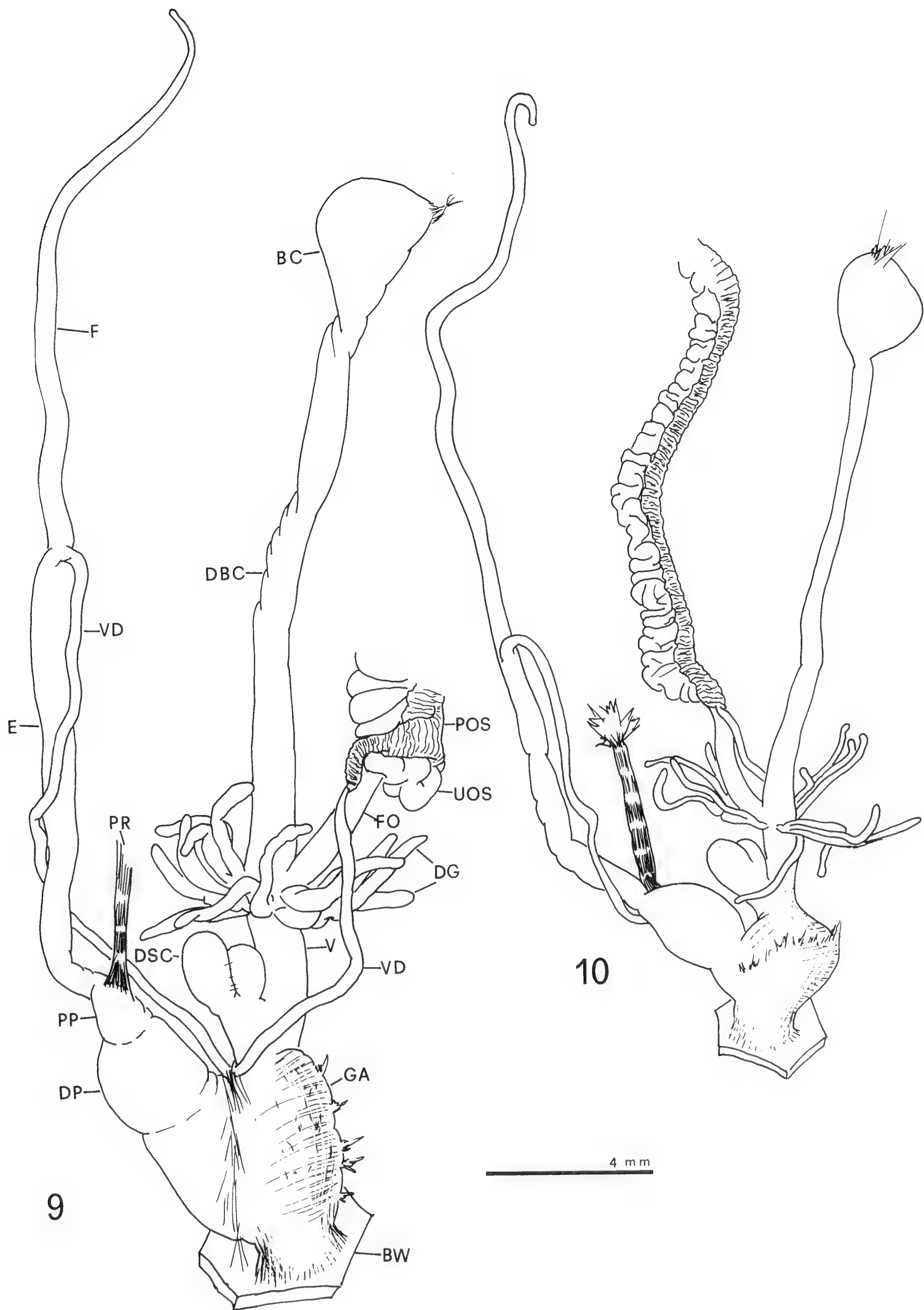




Figs. 1–5. *Xerosecta giustii* n. sp. Holotype (Fig. 1) and four paratypes (Figs. 2–5), Boccheggiano (Boccheggiano, Grosseto), 32TPN67, G.M. leg. 16.2.91.

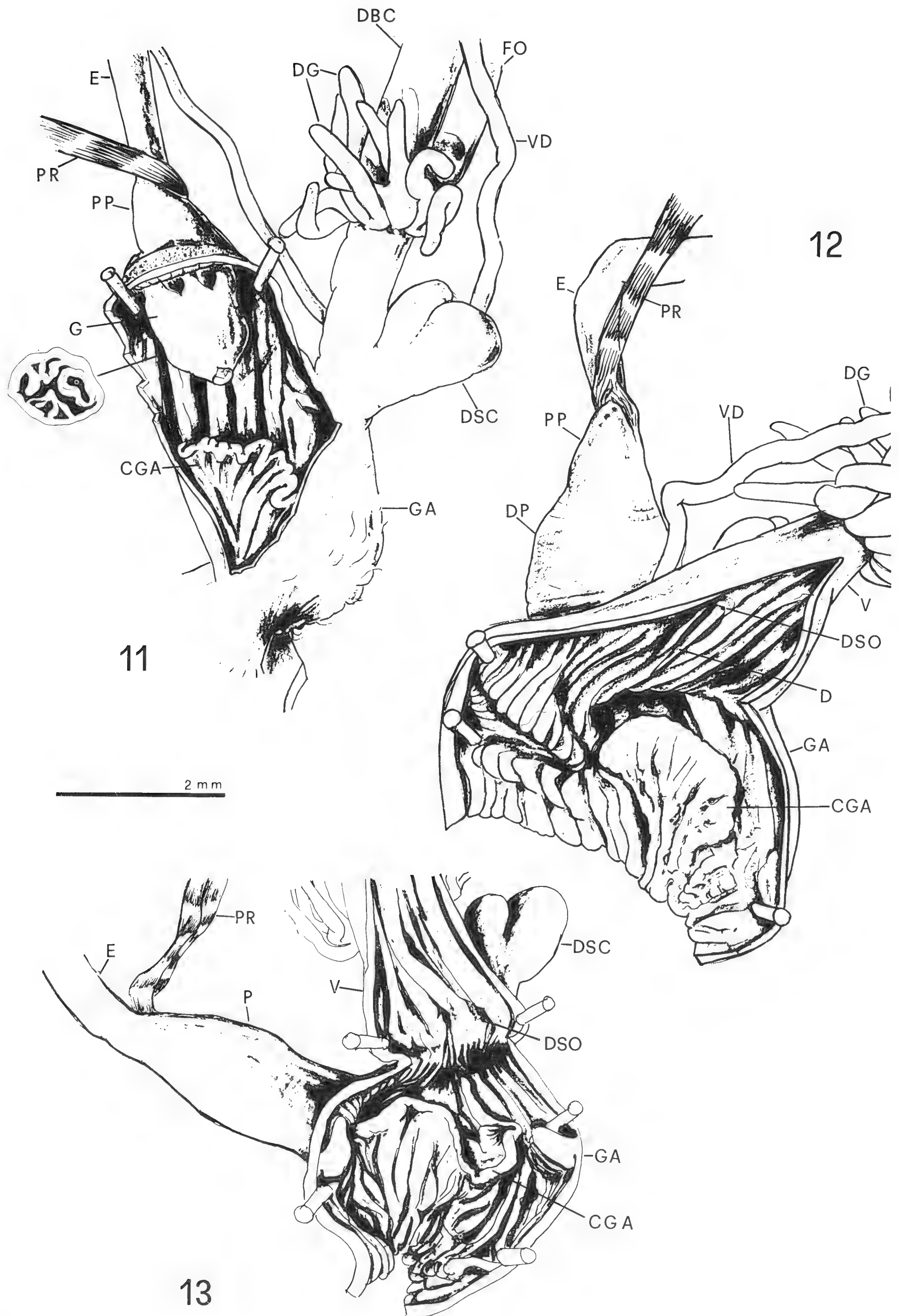


Figs. 6–8. Genitalia (gonad excluded) (6), digitiform glands (7) and dart (8) of *Xerosecta giustii* n. sp.

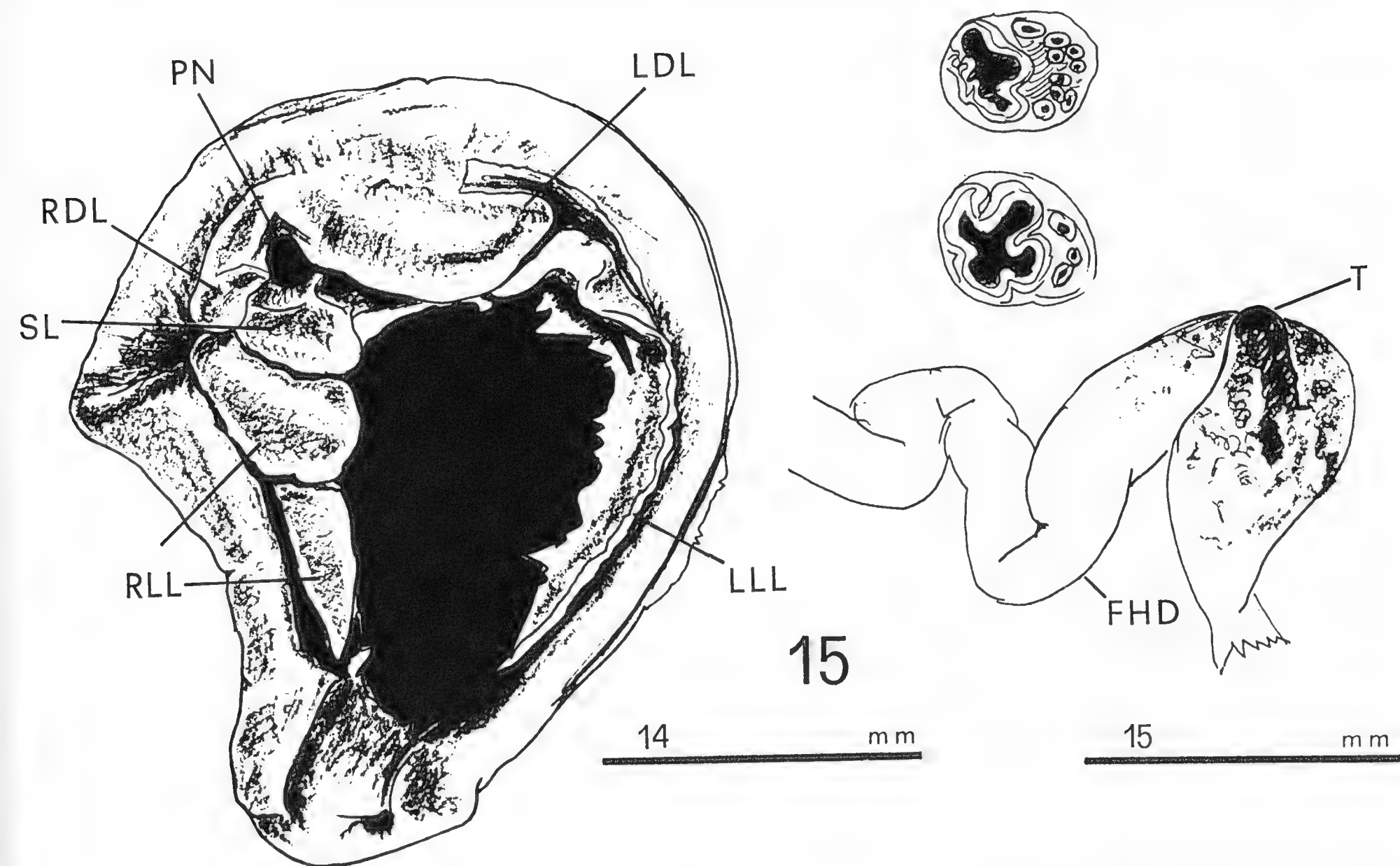


Figs. 9–10. Genitalia (gonad to part of ovispermiduct excluded) of *Xerosecta giustii* n. sp.





Figs. 11–13. Details of distal genitalia of *Xerosecta giustii* n. sp. Distal penis and part of genital atrium open to show penial papilla and crest-like structure [11]; vagina and genital atrium open to show dart-sac complex opening and crest-like structure (12–13).



Figs. 14–15. Mantle edge and talon (with two enlarged sections, the lowermost proximal, the uppermost distal) of *Xerosecta giustii* n.sp.

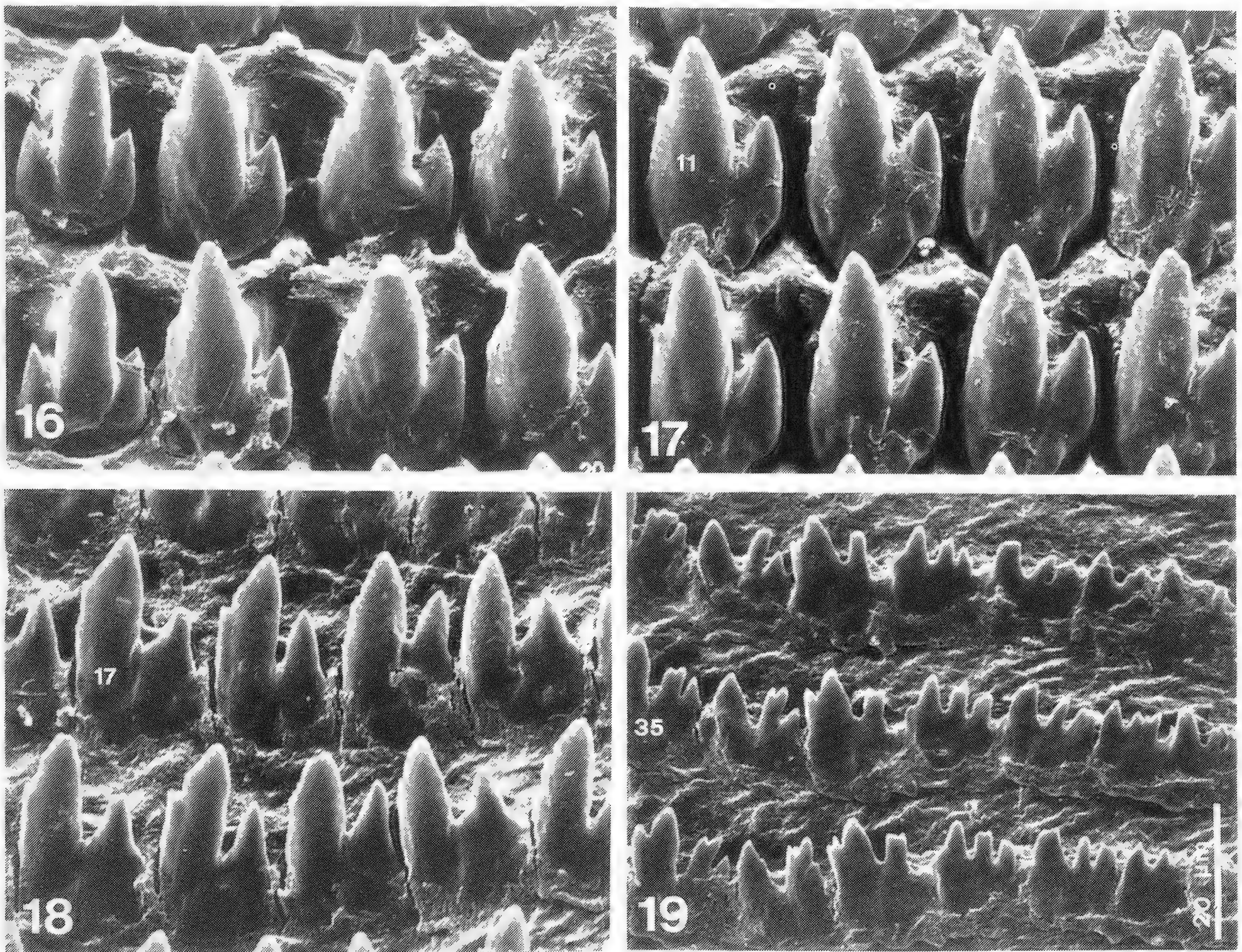
**Body and general anatomy:** Animal yellowish-grey in colour, pale slate-grey on head and neck; mantle border (Fig. 14) pale slate-grey with five lobes: right lateral lobe triangular sometimes with deep incision at half its length; right dorsal lobe small, bean-like; left dorsal lobe large, with obtusely pointed tip; subpneumostomal lobe large, square; left lateral lobe long, laminar; foot with non-partite sole of holopode type, yellowish on sides, pale slate-grey at centre; wall of pallial cavity slate grey with black stripes near mantle border; retractor of right ommatophore free of penis and vagina; sigmurethrous kidney; jaw of odontognathous type; penial nerve from right cerebral ganglion.

**Shell:** Shell (Figs. 1–5) dextral, medium-sized, subglobose to depressed, robust; protoconch dark reddish-brown; teleoconch uniformly grey to whitish-grey in colour, with collabral flecks, and sometimes one usually faint discontinuous brown band above periphery and traces of other smaller, ill-defined bands on lower part of last whorl near peristome; external surface of teleoconch marked with well-defined, irregularly spaced growth lines; spire conical, moderately to slightly raised, with  $5\frac{1}{2}$ – $6\frac{1}{3}$  regularly growing, convex whorls, last whorl large, dilated and more or less descending near aperture; sutures deep; umbilicus open, wide about  $\frac{1}{4}$ – $\frac{1}{5}$  of the maximum shell diameter; aperture oblique, elliptical to oval-round; peristome interrupted, thin, slightly reflected at external, lower and columellar margins, with internal, relatively thick, whitish rib.

Dimensions of the shell, see Table 1; dimensions of the holotype: shell diameter: 18.5 mm; shell height: 11.5 mm; aperture diameter: 8.6 mm; aperture height: 7.8 mm.

**Genitalia:** General scheme of genitalia (Figs. 6–13, 15) of semidiaulic monotrematic type. Convolted first hermaphrodite duct (functioning as seminal vesicle) arising from multilobate gonad and ending laterally in talon (i.e. fertilization chamber plus seminal receptacle complex); talon lying on inner surface of large albumin gland, proportionally short and wide, black pigmented, its transverse section showing wide fertilization chamber, inner surface of which with wrinkled walls and 2–3 seminal receptacles apically branched into 9





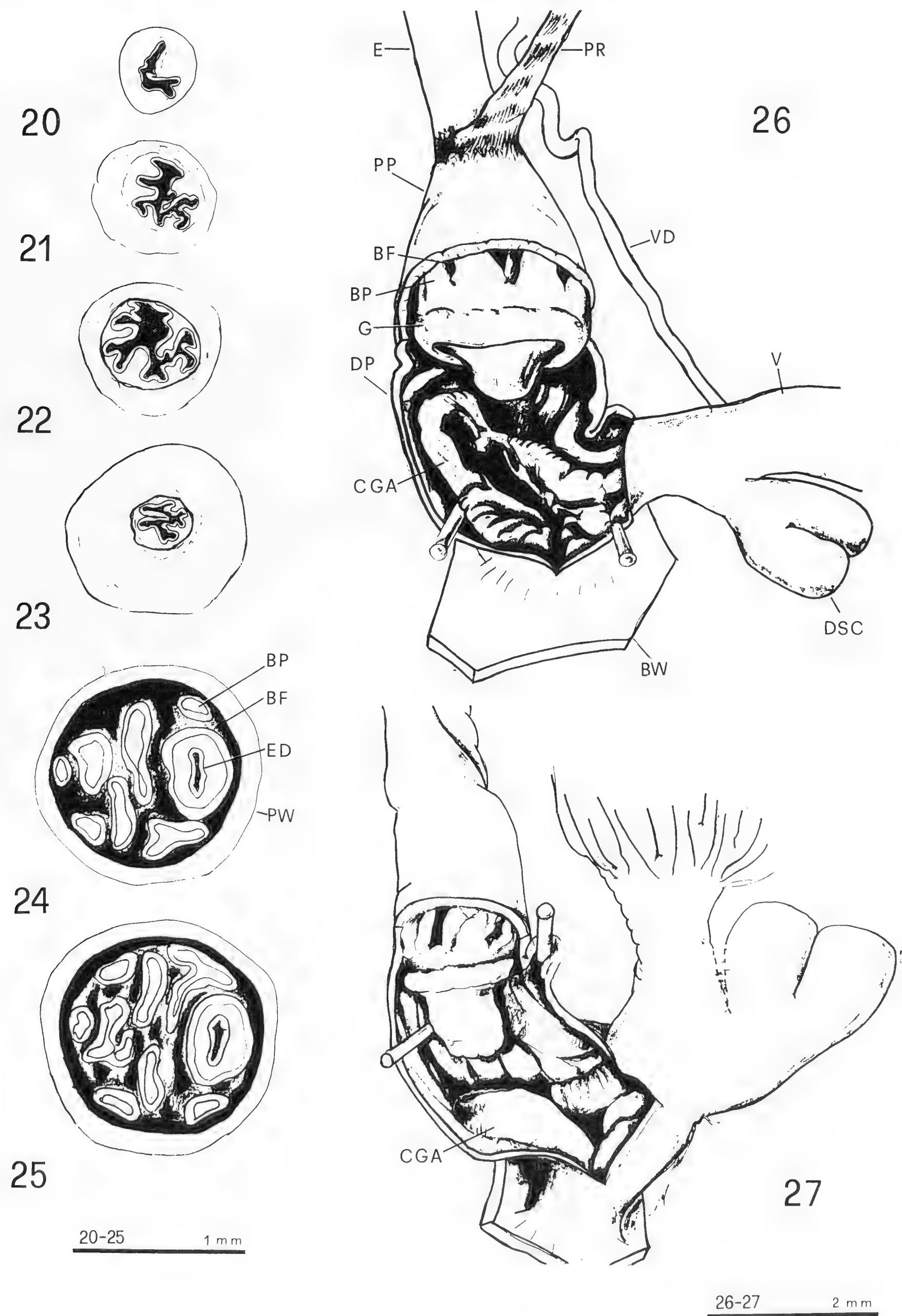
Figs. 16–19. Radula of *Xerosecta giustii* n.sp. scale bar = 20 $\mu$ m.

thin, blind tubules (Fig. 15); albumin gland connected to wide ovispermiduct (second hermaphrodite duct) consisting of prostatic and uterine portions. Prostatic portion continuing distally into long, thin vas deferens and penial complex.

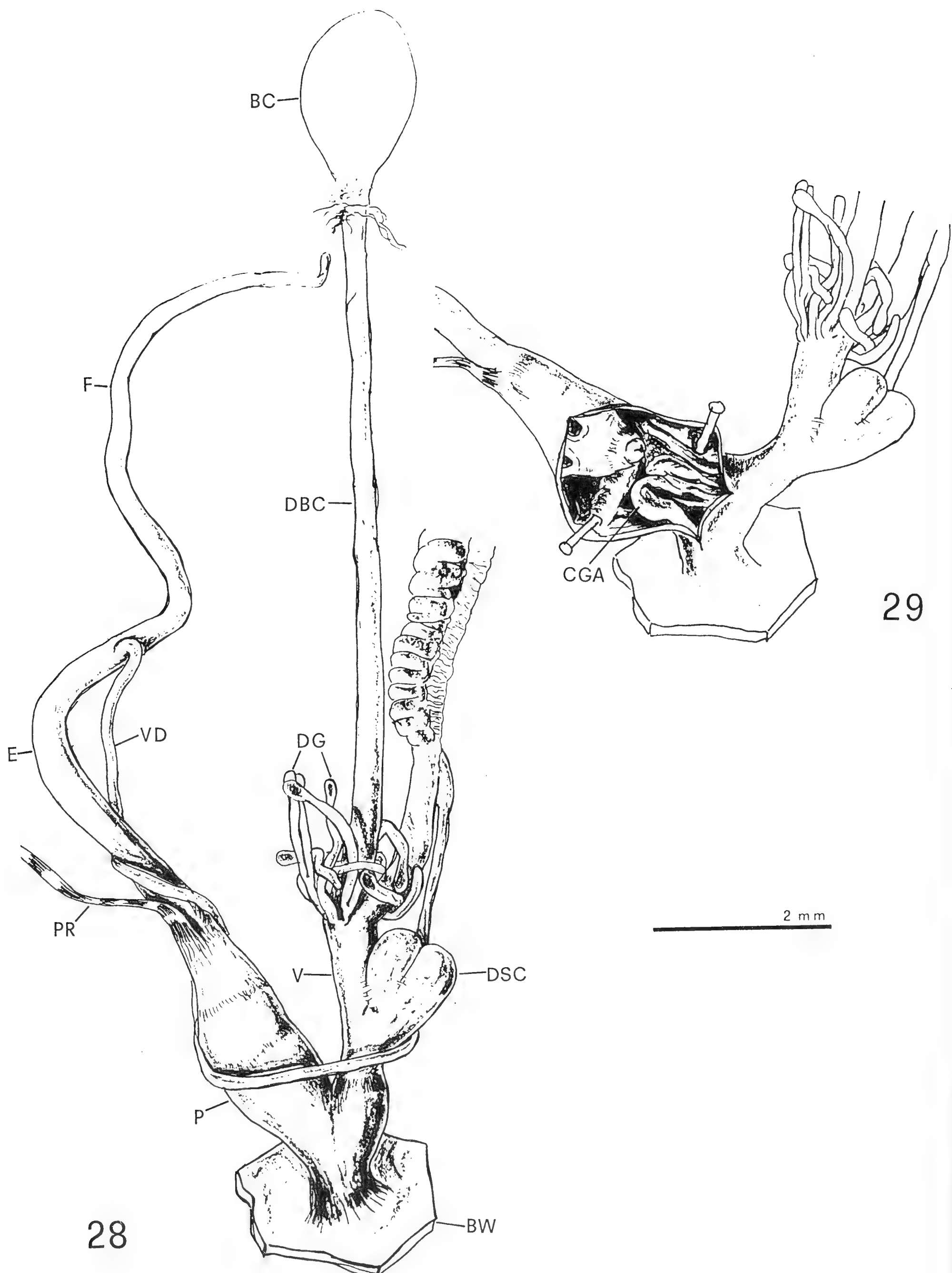
Penial complex (Figs. 6, 9–10) consisting of flagellum, epiphallus (i.e. from end of vas deferens to point of attachment of penial retractor) and penis (i.e. from point of attachment of penial retractor to genital atrium). Penial flagellum very long (16.5–17.2 mm;  $n = 3$ ) and slender, its diameter gradually decreasing to tip. Epiphallus slightly wider in diameter than base of flagellum, about half flagellum length (8.4–12.6 mm;  $n = 12.6$  mm;  $n = 3$ ), its internal walls with series of parallel pleats ending level with where constriction marks beginning of proximal penis (and where penial retractor joins external wall of penial complex). Penis approximately 1/3 epiphallus length (2.6–3.9 mm;  $n = 3$ ), without penial sheath, distinguished into two portions: short proximal penis and longer, dilated distal penis. Distal penis containing penial papilla (Fig. 11); penial papilla of *Xerosecta*-type, short, conical, with subapical or apical opening, its transverse section showing lateral ejaculatory duct enveloped by peculiar sheath; sheath provided with basal fenestrations and internally branched projections to form sort of corpus cavernosus.

Female portion (Figs. 6, 9–10) of ovispermiduct distally joined to free oviduct of medium length (2.7–3.4 mm;  $n = 3$ ) ending in vagina level with point of entry of bursa copulatrix duct. Bursa copulatrix duct long (7.2–12.8 mm;  $n = 3$ ), uniform in diameter for most its length, slightly flared before entering proximal vagina. Bursa copulatrix (gametolytic gland) proportionally small, oval to roundish. Beginning of vagina marked by 4 tufts of more or less branched digitiform glands disposed all around at regular intervals. Proximal vaginal (from





Figs. 20–27. Internal structure of penis and genital atrium and sections of the penial complex of *Xerosecta cespitum* from Fontana Povera (Rocchetta Nervina, Imperia), 32TLP86, A. Boato leg. 19.9.78 (Figs. 20–26) and internal structure of penis and genital atrium of *Xerosecta “arigonis”* from Scalextric de la Universidad, Vizcaya (Spain), 30TWN09, C. Prieto leg. 30.8.90 (Fig. 27). Section of: medial epiphallus (20), terminal epiphallus (21), medial proximal penis (22), terminal proximal penis (23) and distal penis level with the penial papilla (24–25). Note that the differences in shape of the penial papilla of *X. cespitum* and *X. “arigonis”* are not species-specific but only due to a different degree of infolding of the ejaculatory duct.



Figs. 28–29. Genitalia (gonad to part of ovispermiduct excluded) and internal structure of penis and genital atrium of *Xerosecta explanata* from Frontignan Plage (France), S. Cianfanelli leg. 15.8.93.

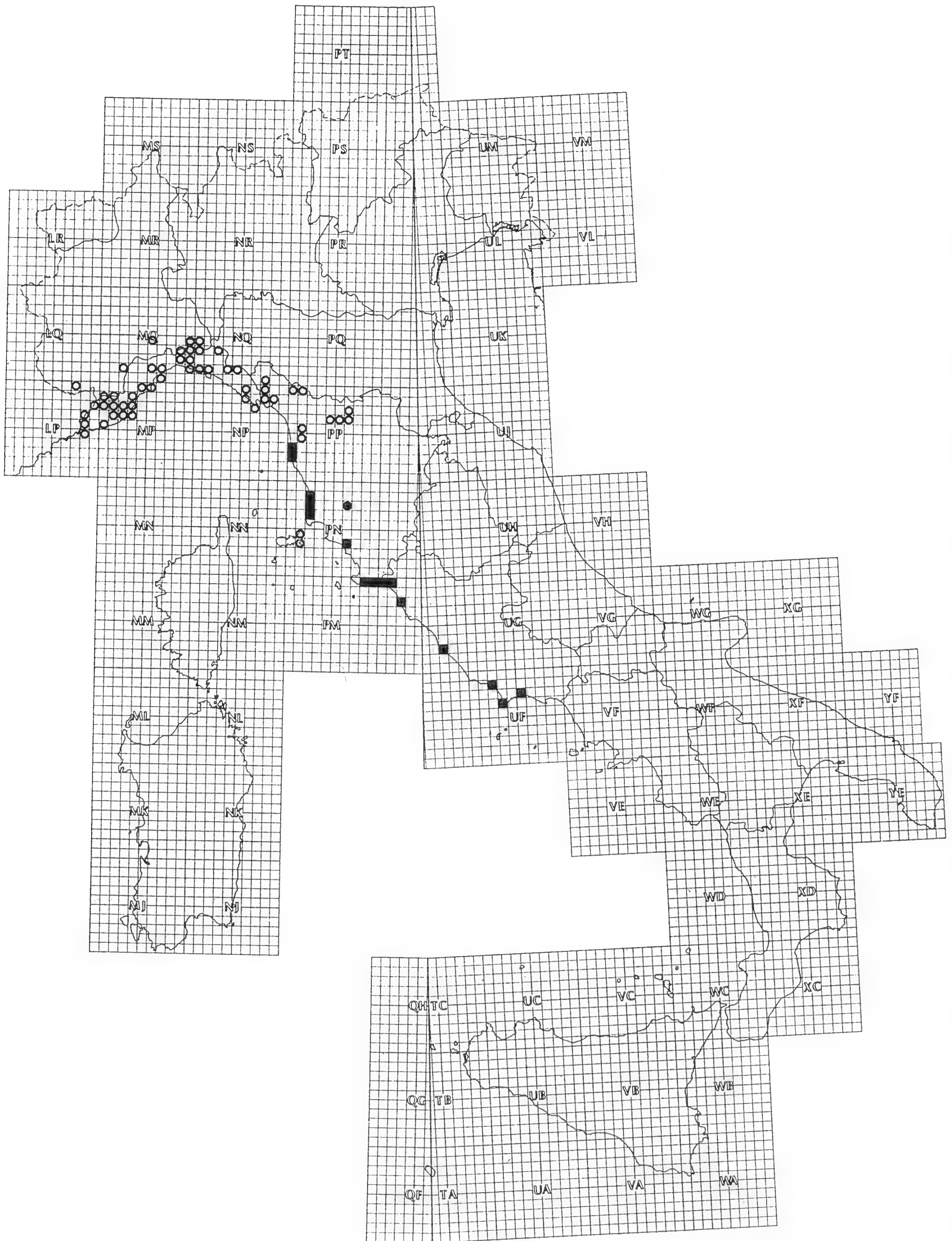


Fig. 30. Distribution of *Xerosecta giustii* n. sp. (full dot), *X. cespitum* (empty dots) and *X. contermina* (full squares) plotted on the UTM map of Italy. Distribution of *X. cespitum* and *X. contermina* based only on personal data listed in the Appendix. Corsican and Sardinian *Xerosecta* omitted due uncertainty as to their taxonomic status.



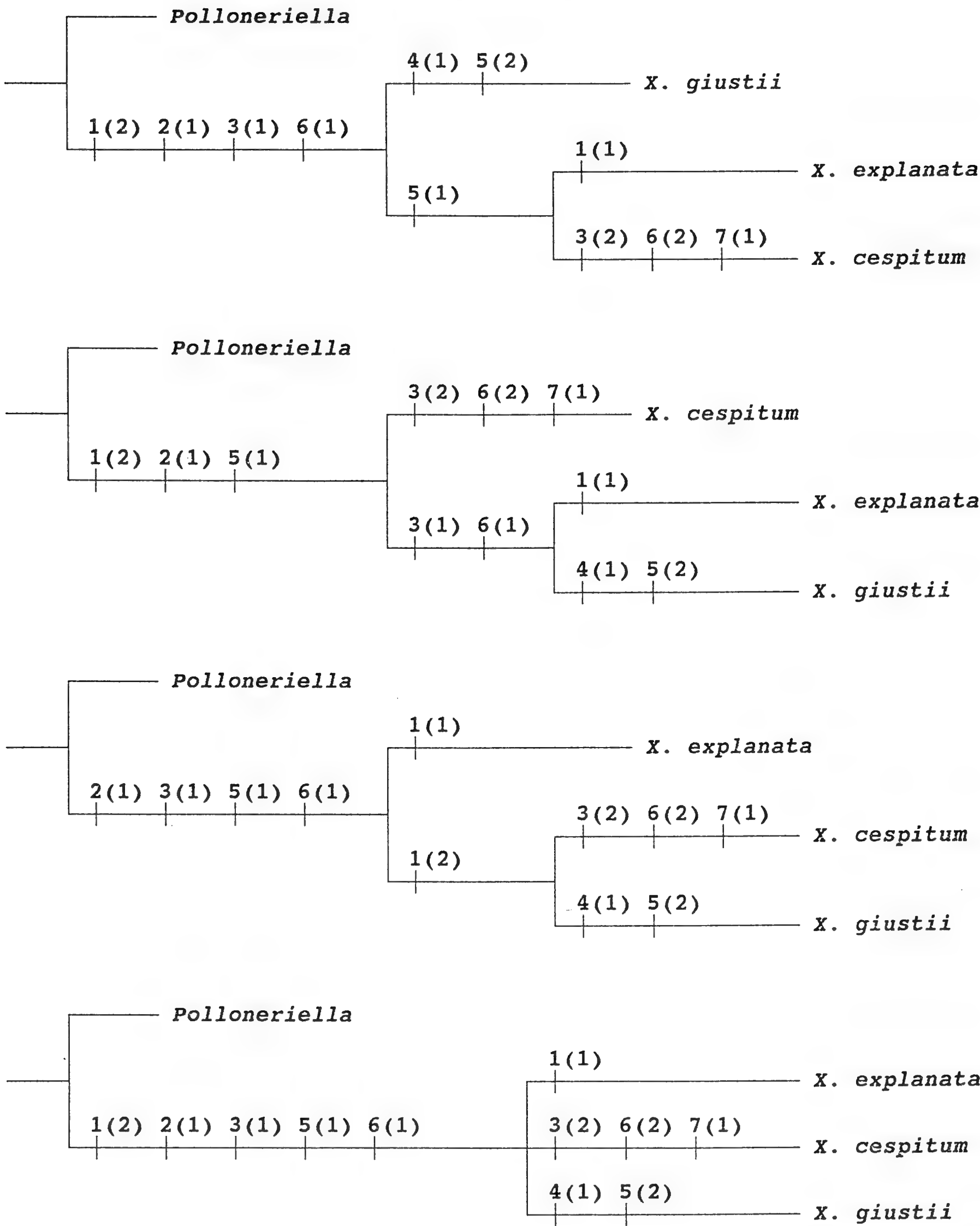


Fig. 31. The four, all equally parsimonious, phylogenetic hypotheses consistent with the data matrix. On the trees is indicated the evolution of the characters.

TABLE 1  
Dimensions of the shell of *Xerossecta giustii* n. sp.

	range	$\bar{x} \pm \text{sd}$	n
shell diameter	15.2–24.2 mm	19.1 ± 2.2	20
shell height	8.2–14.0 mm	10.9 ± 1.9	20
diameter of aperture	7.2–12.0 mm	9.0 ± 1.1	20
height of aperture	6.5–10.8 mm	8.1 ± 0.9	20

where bursa copulatrix canal ends to where dart-sac complex enters vagina) (2.9–3.1 mm;  $n = 3$ ), as long as free oviduct. Dart-sac complex connected by sort of stalk to one side of vagina, consisting of one outer, larger, dart-bearing, and one smaller, inner, dartless stylophore, disposed side by side (0 + 2 dart-sac complex); outer stylophore separated from inner for more than half its length; outer stylophore with thinner muscular walls and narrow lumen; inner stylophore with less thick walls and larger lumen, irregularly shaped; cavities of stylophores end side by side in common opening into vagina, bordered by two pleats (Figs. 12–13). Other pleats, in variable number, run longitudinally on internal walls of vagina. Dart (Fig. 8) long, protruding into vagina, with wide irregularly shaped basal portion, gradually tapering to tip and gently curved, oval in section, with two wings on sides corresponding to major axis; lateral wings running for most of dart length to fuse at tip.

Penis and vagina open side by side into enormously developed genital atrium. Genital atrium almost globular; internal walls of genital atrium with many pleats, distally forming large, superficially pleated, fan-like crest.

*Radula*: Radula (Figs. 16–19) consisting of many rows of teeth each with 77–83 teeth according to the formula  $38 - 41 + C + 38 - 41$ ; central tooth with wide basal plate and raised pointed upper vertices; body of tooth with very large mesocone and two small ectocones,  $1/3$  of mesocone height; first lateral teeth having wide basal plate but with inner vertex missing; body with large pointed mesocone and small ectocone  $1/4$  of mesocone height; from first lateral teeth, inner side of mesocone showing slight protuberance developing into pointed cusp in following lateral and marginal teeth; moving laterally, teeth maintain same shape but progressively decrease in size, with more pointed cusps and reduced basal plate; last marginal teeth having mesocone apex with 2–3 cusps and ectocone split into 2–4 smaller points.

*Origin of the name*: Named after Folco Giusti, as a token of our highest esteem and brotherly companionship and in recognition of his teaching.

*Habitat*: The only population known inhabits a site with garigue vegetation on karstland not wider than an hectare. It is found on soil, under stones, in rock faces, on the branches of bushes and grass stems.

*Distribution*: Endemic to the Colline Metallifere in southern Tuscany.

## DISCUSSION

*Nomenclature*: Before differentiating and analyzing the relationships of the new species to the others of *Xerosecta* it is necessary to ascertain that among the numerous new names created by past authors for the hygromiids, one is not already available for the new species.

Many nominal taxa of the species group have been introduced for different, recent and “subfossil” “species”, forms or varieties of *Xerosecta cespitum* (Draparnaud, 1801) from Liguria and Tuscany. They are: *Helix aerumnosa* Pollonera in Caziot, 1904 (type locality: “Ile de Palamaria (Golfe de La Spezia)”), *Helix (Xerophila) cespitum* var. *alticola* Nevill, 1880 (type locality: “Menton”), *Helix (Xerophila) cespitum* var. *dismasthia* Nevill, 1880 (type locality: “Alassio, near Genoa”), *Helix cespitum* var. *introducata* (Schmidt, 1855: type locality: “bei Genua und Spezzia”), *Xerophila cespitum* var. *mauriciensis* Pollonera, 1893 (type locality: “Porto Maurizio. Nizza, Saorgio, Tenda e Limone”), *Helix Pisanorum* Bourguignat in Locard, 1882 (type locality: “en Italie, aux environs de Pise, et, en France, à Roquefavour, dans les Bouches-du-Rhône”), *Xerophila cespitum* var. *remuriana* Pollonera, 1893 (type locality: “San Remo e Porto Maurizio”), *Helix (Xerophila) sclera* Nevill, 1880 (type locality: neighbourhood

of Menton), *Xerophila cespitum* var. *sospitelliana* Pollonera, 1893 (type locality: "Sospello e contorni di Nizza"), *Helix* (*Xerophila*) *terveri* var. *subarenarum* Nevill, 1880 (type locality: neighbourhood of Menton), *Helix* (*Xerophila*) *subcespitum* Nevill, 1880 (type locality: neighbourhood of Menton), *Xerophila cespitum* var. *turgescens* Pollonera, 1893 (type locality: "Monte dei Cappuccini a Spezia e Isola del Tino all'entrata del Golfo della Spezia"), *Xerophila cespitum* var. *vediantia* Pollonera, 1893 (type locality: "Vernante e limone in Piemonte; Saorgio e Badalucco in Liguria"). All must be regarded as junior synonyms of *Xerosecta cespitum* (Coutagne, 1895; Germain, 1929; Alzona, 1971; Richardson, 1980). Most of these names were introduced for varieties or forms. The publication of a scientific name as the name of a variety or form before 1961 does not prevent availability [Art. 16], however, it is necessary to determine its original rank, i.e. if it was subspecific or infrasubspecific, since infrasubspecific names are excluded from the zoological nomenclature [Arts. 1 b (5), 16]. The original rank of a new name, expressly published for a "variety" or "form" is subspecific if published before 1961. However, if the content of the work reveals that infrasubspecific rank was meant, the name is infrasubspecific unless, prior to 1985, it was treated as an available name and either adopted as the name of a species or subspecies or treated as a senior homonym [Art. 45 g]. With the sole exception of *Helix cespitum* var. *introducata* Schmidt, 1855, all the others seem originally to have been of infrasubspecific rank, and were never utilized as valid names for taxa of the species group. Although some authors list them as synonyms, they are of infrasubspecific rank and hence invalid, and should be excluded from the zoological nomenclature.

We also carefully studied all nominal taxa of large xerophilous hygromiids described from the northern and central Appenine regions (Liguria, Tuscany, Emilia, Umbria, Marche, Abruzzo, Latium) and we also checked that some of them did not correspond to the new species. Although the same problems of original rank apply to some, the following correspond to *Cernuella* (s.str.) *virgata* (Da Costa, 1778) (see Alzona, 1971): *Xerophila* (*Xerolauta*) *peninsularis* forma *clitumni* Kobelt, 1907 (type locality: "Aufenthalt in der Ebene des Clitumnus an der alten Heerstrasse von Foligno nach Spoleto"), *Xerophila* (*Xerolauta*) *peninsularis* forma *coneri* Kobelt, 1907 (type locality: "Monte Conero bei Ancona"), *Xerophila pistoriana* var. *genuensis* Pollonera, 1892 (type locality: "Genova, presso il mare"), *Xerophila janalis* Pollonera, 1892 (type locality: "Genova"), *Xerophila limarella* var. *major* Pollonera, 1892 (type locality: "Genova e Rapallo in Liguria, e Pistoia in Toscana"), *Xerophila limarella* var. *maxima* Pollonera, 1892 (type locality: "Siena"), *Xerophila pistoriana* Pollonera, 1892 ("Pistoia e Siena in Toscana; Nizza"), *Xerophila senensis* Pollonera, 1892 (type locality: "Siena e Pistoia in Toscana").

On the contrary others such as *Helix ammonis* subvar. *bononiensis* De Stefani, 1883 (type locality: "Bologna nelle pendici settentrionali dell'Appennino"), *Helix discrepans* Tiberi, 1878 (type locality: "les environs de Gessopalena, de Civitaquana et de Barisciano"), *Helix ammonis* var. *major* Kobelt, 1877 (type locality: "Ascoli Piceno"), *Xerophila nerusia* Pollonera, 1892 (type locality: "Grasse e Nizza"), and perhaps *Xerophila mendica* Pollonera, 1892: (type locality: "Rapallo"), *Xerophila limara* var. ? *popella* Pollonera, 1892 (type locality: "Port Maurizio") and *Xerophila trepidulina* Pollonera, 1892 (type locality: "Contorni di Nizza, Mentone e Alassio") can be attributed to *Cernuella neglecta* (Draparnaud, 1801) (see Alzona, 1971).

Some other nominal taxa of different genera (*Candidula* and *Trochoidea*) have been described for the northern and central Apennine regions, but for small sized species, with the exception of *Candidula spadae* (Calcara, 1845) (type locality: "Monte Vettore") and its junior synonym, *Helix bathyomphala* Pfeiffer, 1848 (type locality: "Ascoli").

Finally, although the status of *Helix rugosa* Lamarck, 1822 (type locality: "Habite en Italie, sur la route d'Ancône à Sinigaglia") is questionable, this nominal taxon has nothing to do with the *Xerosecta* species (Manganelli *et al.*, 1995).



**Taxonomy:** The new species is easily distinguished from all the other species of *Xerosecta*, both conchological and anatomically.

Conchologically its shape and chromatic pattern enable it to be readily differentiated from the other species. *X. explanata* (Müller, 1774) has a small-sized, depressed above and convex below, yellowish-white or tawny shell with a keel above the periphery, (Gasull, 1975: 93, Pl. 3, fig. 23; Testud, 1981: 226, Figs. 1–3; Kerney *et al.*, 1983: 300, Fig. at p. 300; Falkner, 1990: 210, Fig. 6 at p. 211). *X. cespitum* (Draparnaud, 1801) has a medium-sized, subglobose or depressed shell, moderately umbilicated, usually yellowish-white or tawny often with many discontinuous chestnut-coloured bands (Kerney *et al.*, 1983: 300, Figs. at p. 300 and 301; Aparicio, 1985: Fig. 1, 3; Bogon, 1990: 314, Fig. at p. 315; Falkner, 1990: 210, Fig. 3–4 at p. 211). *X. “arigonis”* (Schmidt, 1853), has a medium-sized subglobose shell, narrowly umbilicated, coloured as *X. cespitum* (Gasull, 1975: 75, Pl. 2, fig. 12; Manga Gonzalez, 1978: Fig. a p. 89; Manga Gonzalez, 1984: 182, Pl. 2, figs. 10–12; Prieto, 1986: 328, Pl. 10, fig. 6).

Anatomically *X. giusti* is easily distinguished by virtue of its large genital atrium containing a large pleated, semilunar, crest-like structure. Other *Xerosecta* species (Figs. 26–27, 29) have a normally developed genital atrium containing an equivalent structure which is no more than a robust pleat. Other differences with respect to *X. cespitum* and *X. “arigonis”* include the lesser branched digitiform glands and some features of the penial papilla (see Figs. 20–29 and Table 1; see also for *X. explanata*: Moquin Tandon, 1855: Pl. 17, figs. 24–25; Germain, 1930: Fig. 234; and Manganelli & Giusti, 1988: Figs. 8 A–D, 14 E; for *X. cespitum*: Schmidt, 1855: 31, Pl. 7, fig. 42 [as *Helix cespitum* var. *introducata*]; Germain, 1930: Fig. 221; Hesse, 1934: 18–20, Pl. 3, fig. 25 a–c; Aparicio, 1985: Figs. 2, 4; Marquet, 1985: 8, Fig. 3; and Manganelli & Giusti, 1988: Figs. 9 A–E, 14 F; for *X. “arigonis”*: Ortiz de Zarate, 1950: 69–72, Fig. 17; Clerk & Gittenberg, 1977: 48, Figs. 98–101; Aparicio, 1982: Fig. 2; Manga Gonzalez, 1978: Fig. at p. 87; Manga Gonzalez, 1984: 182–184, Fig. 14; Prieto, 1986: 328–329, Fig. 98).

Other “species” of *Xerosecta* have been described from Maghrebian North Africa, often as being related to the French *Helix abella* Draparnaud, 1801 [= *X. explanata* (Müller, 1774)] and *Helix terveri* Michaud, 1831 [a junior synonym of *X. cespitum* (Draparnaud, 1801)?]. Some of them were studied anatomically and reported as *Jacosta* and *Xeromagna* by Hesse (1933), Ortiz de Zarate (1950), Alonso (1975) and Aparicio (1982). However, despite these anatomical reports their status is very uncertain and sometimes indeterminate. Due to the absence of modern revisions, these studies are obsolete: they were often performed without consideration of the type series, without character analysis or weighting, and on non-topotypical specimens. Not one of the “species” studied anatomically has genitalia with an enormously developed genital atrium like *X. giustii* (see for *X. adolfi* (Pfeiffer, 1854): Ortiz de Zarate (1950: 66, 73, Fig. 18) and Alonso (1975: 18, Pl. 3, fig. 2); for *X. reboudiana* (Bourguignat, 1864): Ortiz de Zarate (1950: 66, 79–80, Fig. 21), Alonso (1975: 19–20, Pl. 4, fig. 1) and Aparicio, 1982: 621, Fig. 1); for *X. submeridionalis* (Bourguignat, 1864): Ortiz de Zarate (1950: 66, 78, Fig. 20) and Alonso (1975: 19, Pl. 4, fig. 2); for *X. subrostrata* (Terver, 1839): Ortiz de Zarate (1950: 66, 75, Fig. 19) and Alonso (1975: 20)). Some other species were dissected by Hesse (1934): *Helicella* (*Xeromagna*) *sphaerita* (Hartmann, 1844) from Oran, *H. (X.) pampelonensis* (Schmidt, 1855) from Navarra, *H. (X.) euphorcella* (Bourguignat in Pechaud, 1887) from Palikao, *H. (X.) globuloidea* (Terver, 1839) from Lella Marnia, *H. (X.) colomiesiana* (Bourguignat, 1863) from Oran, *H. (X.) illibata* (Rossmässler, 1939) from Oran, *H. (X.) oranensis* (Morelet, 1852) from Oran, *H. (X.) indigens* (Pollonera, 1893) from Ben Aknoun bei Alger, but the information given about them is inadequate (dimension of the flagellum, epiphallus, penis, dart, duct of the bursa copulatrix and number of the digitiform glands).

**Systematics:** Table 2 lists the characters considered in analyzing the relationships between the

TABLE 2

## List of characters

- 1 – shell size and shape
  - small and globose = 0
  - small – medium and keeled = 1
  - medium = 2
- 2 – ejaculatory duct
  - central = 0
  - lateral = 1
- 3 – digitiform glands
  - 2 tufts, each with two branches = 0
  - 4–5 tufts, each with two-three branches = 1
  - 4–5 tufts, each with many branches = 2
- 4 – genital atrium
  - normally developed = 0
  - enormously developed = 1
- 5 – atrial structure
  - absent = 0
  - as a robust pleat-like structure
  - as a large crest-like structure
- 6 – corpus cavernosus in subapical section of the penial papilla
  - absent = 0
  - explanata*-like (Manganelli & Giusti, 1988: Fig. 8C) = 1
  - cespitum*-like (Manganelli & Giusti, 1988: Fig. 9E) = 2
- 7 – apex of penial papilla
  - without a subapical annular ring = 0
  - with a subapical ring

new species and the other *Xerosecta* species. Due to the many taxonomical and anatomical uncertainties of some alleged *Xerosecta* species, we limited our consideration to *X. cespitum* and *X. explanata*, since their anatomy is known in detail.

Character polarity was determined using the outgroup comparison method, taking the subgenus *Polloneriella* as outgroup (type species: *Helix contermina* Pfeiffer, 1847). *Polloneriella* and *Xerosecta* share many character states (penial nerve from cerebral ganglion; retractor of the right ommatophore free from genitalia; 0 + 2 dart-sac complex; dimensions and shape of inner stylophore; stylophore opening; structure of penial papilla). Although many of these character states may be symplesiomorphies, at least on the basis of available information, the structure of the penial papilla, (ejaculatory, duct enveloped by an external, basally fenestrated sheath), is unique and may be constitute a synapomorphy of the *Polloneriella* – *Xerosecta* group (Manganelli & Giusti, 1988; Giusti *et al.* 1992).

Four out of seven characters had more than two character states; these characters were considered non-additive (= non-ordered); two characters were autoapomorphies and four additional autoapomorphies were found embedded in the multistate non-additive characters.

The four possible phylogenetic hypotheses (Fig. 31) were all equally parsimonious, 11 steps along, and 100% consistent with the data matrix. Three out of four trees were dichotomous, and the fourth trichotomous. In the dichotomous trees the relationships between the three *Xerosecta* species were interpreted as follows: 1) *Xerosecta* is a monophyletic group based on 1 (1), 2 (1), 3 (1) and 6 (1); *explanata* and *cespitum*, based on 5 (1), is a sister group of *giustii*; 2) *Xerosecta* is a monophyletic group based on 1 (1), 2 (1), 5 (1); *explanata* and *giusti*, based on 3 (1) and 6 (1), is a sister group of *cespitum*; 3) *Xerosecta* is a monophyletic group based on 2 (1), 3 (1), 5 (1) and 6 (1); *cespitum* and *giustii*, based on 1 (1), is a sister group

TABLE 3

Taxa and data matrix.

taxa	1	2	3	characters 4	5	6	7
<i>Polloneriella</i>	0	0	0	0	0	0	0
<i>X. explanata</i>	1	1	1	0	1	1	0
<i>X. giustii</i>	2	1	1	1	2	1	0
<i>X. cespitum</i>	2	1	2	0	1	2	1

of *explanata*. In the trichotomous tree, *Xerosecta* is a monophyletic tree based on 1 (1), 2 (1), 3 (1), 5 (1) and 6 (1).

As all the possible phylogenetic hypotheses are possible without extra steps (maximum parsimony), the relationships of the three taxa cannot be resolved until new characters are found.

*Biogeography*: The species is found at the southern limit of the Italian distribution of *X. cespitum* (Fig. 30). Since at present it is known from only one locality, it is difficult to comment on its origin. No other land snail endemic to Tuscan has such a limited distribution, not even the rupicolous *Chondrina oligodonta* (Del Prete, 1879) from the Alpi Apuane, or the insular *Oxychilus oglasicola* Giusti, 1968 and *Ciliellopsis oglasae* Giusti & Manganelli, 1990 both from Montecristo Island. The endemic *Oxychilus uziellii* (Issel, 1872), which like *X. giustii* lives in the Colline Metallifere, is more widespread, reaching the nearby Montagnola Senese and southern Chianti to the north. It is also present in two disjunct stations north of the Arno River in the Appennino Tosco-Emiliano. If other populations of *X. giustii* are not found, only the Maltese land snail *Lampedusa melitensis* (Caruana Gatto, 1892) is known to have so limited a distribution (cf. Giusti *et al.*, 1994) in the western Palearctic.

The Colline Metallifere were part of an island complex during the Pliocene transgression (Ambrosetti *et al.*, 1979; Vai, 1989) and it has been suggested that they may have acted as a refuge (Lanza, 1984). *X. giustii* may therefore have originated from a *X. cespitum* stock which remained isolated from the main distributional area during the Pliocene transgression.

*Status and conservation*: *X. giustii* is only known from the type locality. Despite intensive research in the area, no other population of this species has been localized. This is why only six live specimens were utilized for the study. It was absolutely necessary to exclude that the enormous development of the genital atrium was not an abnormal structure.

Although the type locality abounds in empty shells, live snails were very rare. Only on the third trip, in May 1992, did we succeed in observing hundreds of juveniles and many nearly adult specimens. On the contrary on the next two trips, one at end of 1993 and one at the beginning of 1994, no live specimen was found.

This population did not seem to be threatened by human activity, however it could not be expected to resist accidental fires or the natural evolution of vegetation from garigue to wood. The fact that live snails can now no longer be found may be due to the long drought in the winter of 1992–93 and the spring of 1993 and ploughing of part of the site. Since this is the only known population, the species may be regarded as close to extinction (if not actually extinct).

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## APPENDIX

### Italian localities of *Xerosecta cespitum* (Drapernaud, 1801)

#### Piedmont:

Vallone S. Giovanni, Limone Piemont (Limone, Piemonte, Cueno), 32TLP89, E. Bo leg. 7.88, 7.89.

La Vene, Viozene, (Ormea, Cuneo), 32TMP0089, M. Bodon leg. 1.11.89.

Prale (Ormea, Cuneo), 32TMP18, M. Bodon leg. 1.11.89.

Near l'Arma di Via (Alto, Cuneo), 32TMP18, M. Bodon & A. Boato leg. 20.2.82.

#### Liguria:

Grimaldi (Ventimiglia, Imperia), 32TLP8249, M. Bodon leg. 4.2.84.

Monte Grammondo (Ventimiglia, Imperia), 32TLP85, A. Boato leg. 1979.

Mortola Superiore (Ventimiglia, Imperia), 32TLP8250, M. Bodon leg. 16.4.83.

Torrente Bevera, Calvo (Ventimiglia, Imperia), 32TLP8453, M. Bodon leg. 12.4.79.

Val Roia, Trucco (Airole, Imperia), 32TLP85, M. Bodon leg. 12.4.79.

Fontana Povera (Rocchetta Nervina, Imperia), 32TLP86, A. Boato leg. 25.30.6.78, 19.9.78.

Monte Lega (Pigna, Imperia), 32TLP86, M. Bodon & A. Boato leg. 15.5.82.

Monte Comune (Pigna, Imperia), 32TLP86, M. Bodon & A. Boato leg. 15.5.82.

Monte Pietravecchia (Pigna, Imperia), 32TLP97, A. Boato leg. 1979.

Monte Toraggio (Pigna, Imperia), 32TLP97, A. Boato leg. 19.9.78, 19.6.79, 22.7.79, 23.8.81.

Bussana Vecchia (Sanremo, Imperia), 32TMP05, M. Bodon leg. 29.4.84.

Rezzo (Rezzo, Imperia), 32TMP07, F. Giusti leg. 18.6.77.

Ponte dei Passi (Rezzo, Imperia), 32TMP07, M. Bodon & A. Boato leg. 1982.

Debris of Torrente Argentina, Case dei Corsi (Molini di Triora, Imperia), 32TMP0370, M. Bodon leg. 29.1.84.

Drego (Molini, di Triora, Imperia), 32TMP07, M. Bodon leg. 31.12.80.

Passo d. Teglia (Molini di Triora, Imperia), 32TMP07, M. Bodon leg. 1980.

Mendatica (Mendatica, Imperia), 32TMP08, M. Bodon leg. 14.7.84.

Madonna, dei Cancelli (Cosio d'Arroscia, Imperia), 32TMP08, M. Bodon & A. Boato leg. 29.5.82.

Monte Faudò (Dolcedo, Imperia), 32TMP16, M. Bodon leg. 21.4.84.

Fontana Bramosa (Caravonica, Imperia), 32TMP1572, M. Bodon leg. 30.1.82.

Frantoio Giromela (Imperia, Imperia), 32TMP2164, M. Bodon leg. 5.12.82.

Casanova Lerrone (Casanova Lerrone, Savona), 32TMP27, M. Bodon & A. Boato leg. 4.4.82.

Capo Mele (Andora, Savona), 32TMP36, A. Boato & M. Bodon leg. 30.1.82.

Capo S. Croce (Alassio, Savona), 32TMP37, A. Boato & M. Bodon leg. 30.1.82.

Debris of Rio Torsero. Peagna (Ceriale, Savona), 32TMP38, M. Bodon leg. 17.11.91.

Toirano (Toirano, Savona), 32TMP38, F. Giusti & G. Manganelli leg. 7.4.87.

Carpe (Toirano, Savona), 32TMP38, M. Bodon & A. Boato leg. 24.10.81.

Barescione (Toirano, Savona), 32TMP38, M. Bodon & A. Boato leg. 23.1.82.

Borghetto S. Spirito (Borghetto, S. Spirito, Savona), 32TMP38, M. Bodon & A. Boato leg. 23.1.82.

Monte Ravinet (Loano, Savona), 32TMP38, G. Gardini leg. 11.4.87.

Verzi (Loano, Savona), 32TMP38, M. Bodon & A. Boato leg. 17.3.82.

Quarries above Borgio Verezzi (Borgio Verezzi, Savona), 32TMP49 M. Sosso leg. 1985.

- Caprazzoppa (Finale Ligure, Savona), 32TMP49, M. Bodon & A. Boato leg. 23.1.82.  
 Capo Noli (Noli, Savona), 32TMP59, A. Boata & M. Bodon leg. 1982.  
 Sorgenti del Crivezzo (Noli, Savona), 32TMQ51, M. Bodon leg. 3.3.94.  
 Monte Caprioto (Cavatore, Alessandria), 32TMQ5741, M. Bodon leg. 3.3.94.  
 Punta dell'Olmo (Celle ligure, Savona), 32TMQ61, M. Bodon & A. Boato leg. 20.2.82.  
 Bric del Gazzo, Sestri Ponente (Genova, Genova), 32TMQ8821, M. Bodon leg. 15.5.94.  
 Isoverde (Campomorone, Genova), 32TMQ8931, M. Bodon leg. 4.5.94.  
 Valle del Lagaccio (Genova, Genova), 32TMQ9410, M. Bodon leg. 19.3.94.  
 Maccagno, Nasche (Genova, Genova), 32TMQ9918, M. Bodon leg. 21.3.94.  
 Begato (Genova, Genova), 32TMQ92, M. Bodon leg. 23.6.83.  
 Serra Riccò (Serra Riccò, Genova), 32TMQ9530, M. Bodon leg. 25.8.93.  
 Castello di Savignone (Savignone, Genova), 32TMQ9935, M. Bodon leg. 27.5.90.  
 S. Stefano, Isola del Cantone (Isola del Cantone, Genova), 32TMQ94, M. Bodon leg. 6.9.87 (subfossil).  
 Monte Moro, Genova Quinto (Genova, Genova), 32TNQ0215, M. Bodon leg. 16.3.82.  
 Monte Fascie (Genova, Genova), 32TNQ01, M. Bodon leg. 1980.  
 Rio del Montetto, Genova Nervi (Genova, Genova), 32TNQ01, M. Bodon leg. 8.5.89.  
 Valle Rio Costalunga, Genova Nervi (Genova, Genova), 32TNQ0517, M. Bodon leg. 23.3.93.  
 Rocche del Reopasso (Crocefieschi, Genova), 32TNQ03, M. Bodon, M. Sosso & E. Bo leg. 10.3.89; M. Bodon leg. 29.8.92.  
 Crocefieschi (Crocefieschi, Genova), 32TNQ03, M. Bodon leg. 18.9.83.  
 Monte Maggio, Sorri (Savignone, Genova), 32TNQ03, M. Bodon leg. 18.9.93.  
 Caprioto (Vobbia, Genova), 32TNQ04, M. Bodon leg. 23.9.90.  
 Costa Secca, S. Margherita Ligure (S. Margherita Ligure, Genova), 32TNQ10, M. Bodon leg. 6.11.93.  
 Costa, Nozarego (S. Margherita Ligure, Genova), 32TNQ1607, M. Bodon leg. 29.1.94.  
 Monte Cornua (Sori, Genova), 32TNQ1017, M. Bodon leg. 7.5.94.  
 Monte Borgo (Avegno, Genova), 32TNQ1416, M. Bodon leg. 30.4.94.  
 Montebruno (Montebruno, Genova), 32TNQ23, M. Sosso leg. 1985.  
 Passo del Biscia (Ne, Genova), 32TNQ31, M. Bodon leg. 1979.  
 Val di Vara, Passo del Biscia (Varese Ligure, Spezia), 32TNQ31, M. Bodon leg. 1979.  
 Monte Ventarola (Varese Ligure, Spezia), 32TNQ41, M. Bodon leg. 2.7.83.  
 Scurtabò (Varese Ligure, Spezia), 32TNQ41, M. Bodon leg. 31.10.82.  
 Cassego (Varese Ligure, Spezia), 32TNQ41, M. Bodon leg. 31.10.82.  
 Riomaggiore (Riomaggiore, Spezia), 32TNP58, M. Sosso leg. 1985.  
 Brugnato (Brugnato, Spezia), 32TNP59, M. Bodon leg. 1980.  
 Le Grazie (Portovenere, Spezia), 32TNP67, M. Bodon leg. 27.3.82.  
 Isola Palmaria (Portovenere, Spezia), 32TNP67, M. Bodon leg. 23.10.88.  
 S. Lorenzo (Lerici, Spezia), 32TNP7482, M. Bodon leg. 24.3.91.

## Tuscany:

- Magra River, Santo Stefano di Magra (Santo Stefano Di Magra, Massa Carrara), 32TNP7391, M. Bodon leg. 18.6.94.  
 Fosdinovo (Fosdinovo, Massa Carrara), 32TNP88, M. Bodon leg. 16.6.84.  
 Magra River, La Chiesaccia (Mullazzo, Massa Carrara), 32TPQ7600, M. Bodon leg. 18.6.94.  
 S. Anastasio (Piazza al Serchio, Lucca), 32TPP09, M. Sosso leg. 1985.  
 Camporgiano (Camporgiano, Lucca), 32TPP09, M. Sosso leg. 7.8.86.  
 Magliano a Mattina (Giuncagnano, Lucca), 32TPP0097, A. Merlini leg. 6.90.  
 San Giuliano (San Giuliano Terme, Pisa), 32TPP1647, I. Scali leg. 22.10.89.  
 Monte Bastione (Vecchiano, Pisa), 32TPP1150, M. Bodon leg. 27.12.82.  
 Magnano (Villa Collemantina, Lucca), 32TPP19, M. Sosso leg. 1.4.88.  
 Arcigliano (Pistoia, Pistoia), 32TPP4968, L. Favilli leg. 5.92.  
 Stadio di Pistoia, (Pistoia, Pistoia), 32TPP56, F. Strufaldi leg.  
 Cerreto (Prato, Prato), 32TPP6866, I. Scali leg. 11.89.  
 Le Sacca (Prato, Prato), 32TPP6863, I. Scali leg. 9.89.  
 La Villa (Cantagallo, Prato), 32TPP6977, B. Acciai leg. 3.90.  
 Isola d'Elba: Grotta di Ugliero (Rio nell'Elba, Livorno), 32TPN14, F. Giusti leg. 24.11.74.



Isola d'Elba: Monte Castello (Porto Azzurro-Portoferraio, Livorno), 32TPN13, F. Giusti leg. 23.11.74;  
F. Giusti leg. 20.11.78.

Italian localities of *Xerosecta contermina* (Pfeiffer, 1847)

Calambrone (Pisa, Pisa), 32TPP02, G. Scano leg. 2.90.  
Tirrenia (Pisa, Pisa), 32TPP03, M. Bodon leg. 20.10.83.  
Podere San Lorenzo (Bibbona, Livorno), 32TPN2489, F. Strufaldi leg. 8.79.  
Marina di Castagneto Carducci (Castagneto Carducci, Livorno), 32TPN2581, L.F. leg. 1.7.90.  
Casa Cavalleggeri (San Vincenzo, Livorno), 32TPN2569, L. Favilli leg. 9.7.94.  
Tombolo (Castagneto Carducci, Livorno), 32TPN2579, L. Favilli leg. 10.7.94.  
Marina di Grosseto (Grosseto, Grosseto), 32TPN63, V. Spadini leg. 8.86.  
Tombolo della Feniglia (Orbetello, Grosseto), 32TPM89, L. Favilli leg. 5.7.91.  
Lago di Burano (Capalbio, Grosseto), 32TPM9497, G. Manganelli leg. 6.8.94.  
Graticciaia (Capalbio, Grosseto), 32TQM0194, L.F. leg. 5.7.91; L. F. & G.M. leg. 8.12.91.  
Montalto di Castro Marina (Montalto di Castro, Viterbo), 32TQM19, M. Bodon, M.G. & F.G. leg. 24.11.86.  
Lido di Tarquina (Tarquinia, Roma), 32TQM27, L. Favilli leg. 26.8.91.  
Lido di Castelfusano (Roma, Roma), 33TTG72, L. Castagnolo leg. 29.12.80.  
Torre Paolo (Sabaudia, Latina), 33TUF36, L. Favilli leg. 25.8.91.  
Lido di Capo Portiere (Latina, Latina), 33TUF28, M. Zampetti leg. 30.1.82.  
Terracina (Terracina, Gaeta), 33TUF57, C. Alzona leg.



# THE TAXONOMY AND AFFINITIES OF THE GENUS *PRIODISCUS* (MOLLUSCA; GASTROPODA; STREPTAXIDAE)

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**Abstract:** Two new species of the genus *Priodiscus* are described from Seychelles based on highly distinct shell sculpture, radula tooth number and differences in reproductive anatomy. The systematic position of the genus is reviewed, concluding that its inclusion in the family Rhytididae is doubtful. Several anatomical characters are described that allow the Rhytididae and Streptaxidae to be distinguished, these demonstrate that this anomalous genus shows greater affinity to the Streptaxidae.

**Key words:** Seychelles, taxonomy, systematics, Streptaxidae, Rhytididae

## INTRODUCTION

The genus *Priodiscus* is endemic in Seychelles. This genus of small carnivores has been included within both the Streptaxidae and, more recently, the Rhytididae, its affinities are not clear and its inclusion in the Rhytididae has been questioned (Tillier 1989).

*Priodiscus* was described by von Martens (Martens & Wiegmann 1898) who considered it to show some affinities with the Streptaxidae. It was included within the Rhytididae by Thiele (1931) on the basis of the discoidal shape of the shell and the absence of a central radular tooth. General treatments of Seychelles gastropods have included it within the Streptaxidae (Barnacle 1962, Lionnet 1984, Gerlach 1987). The only attempt to consider the systematic position of the genus to date is Tillier's discussion (Tillier 1989), which retains it as a member of the Rhytididae but without confidence, citing several characters indicative of other affinities.

Shells of this genus are characterised by their flattened, discoidal shape. There is a very distinct keel, a broad umbilicus and a lack of a lip at the mouth edge. There is a strong radial sculpture of raised ridges over at least the first two whorls. Two species have previously been described; *Priodiscus serratus* (Adams) and *P. martensi* Sykes. Both species have Silhouette island as the type locality. Most recent distribution accounts have restricted *P. serratus* to Mahé and Praslin islands, with only *P. martensi* on Silhouette (Barnacle 1962, Lionnet 1984, Gerlach 1987).

Specimens collected by the Oxford University Silhouette Expedition 1990 from Silhouette show that there are two species on the island, both clearly distinguishable from the species on Mahé. Comparisons of this material with the original illustrations of *P. serratus* and *P. martensi* and the type specimens show that the current classification is incorrect. *P. serratus* is the correct name for one of the Silhouette species, but does not occur on Mahé. *P. martensi* is a synonym of *P. serratus*. The second Silhouette species collected by the Oxford University Silhouette Expedition is a new species described here as *P. spinosus*. The Mahé

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species previously recorded as *P. serratus* is also currently unnamed, this is described as *P. costatus*.

These three species are described below. Descriptions are based on the highly distinct shells, radular formulas and reproductive anatomies. The material described is held at the British Museum (Natural History) and in the collection of the Nature Protection Trust of Seychelles.

### SPECIES DESCRIPTIONS

	<b><i>Priodiscus serratus</i></b> (Adams, 1868)
<i>Discus serratus</i> .	Adams, 1868, <i>Proc. Zool. Soc., Lond.</i> <b>16</b> , p. 290.
<i>Priodiscus martensi</i> .	Sykes, 1909, <i>Trans. Linn. Soc., Lond.</i> <b>17</b> , p. 63.
<i>Priodiscus martensi</i> Sykes.	Barnacle, 1962, <i>J. Sey. Soc.</i> <b>2</b> p. 53.
<i>Priodiscus martensi</i> Sykes.	Lionnet, 1984. <i>Biogeography and ecology of the Seychelles islands</i> . p. 240.
<i>Priodiscus martensi</i> Sykes.	Gerlach, 1987, <i>The land snails of Seychelles</i> . p. 6.

*Shell* (Fig 1C & 2B): Shell of 5.5 whorls and one nuclear whorl, usually appearing glossy in fresh specimens; colourless and translucent; discoidal, very strongly keeled with regular ribs on the first whorl. Rest of the shell marked by strong, regular growth ridges on the upper surface of all whorls. Ridges number  $8\text{ mm}^{-1}$  on the body whorl. with alternate ridges being especially pronounced, projecting at the keel, giving the shell a distinct serrated appearance. Underside with only irregular growth lines. Juvenile shells finely, radially sculptured on the under surface. Umbilicus very broad and deep, occupying 25% of the underside of the shell. There is a thin colourless periostracum which is usually detached.

*Dimensions* (mm):

Height	3.7	2.9	3.7	2.5	2.9
Diameter	8.5	5.6	7.0	5.7	5.8

*Body*: The body is a very pale yellow.

*Anatomy*:

*Radula*: Formula = 32 + 0 + 32. The teeth are long, very fine and S-shaped, indistinguishable in shape from those of *P. costatus* (Fig. 4).

*Reproductive anatomy* (Fig. 3B): Spermoviduct inflated in its lower portion, this acts as a brood chamber in all the species of this ovoviviparous genus. A single embryonic shell was found in one of the dissected specimens and a single protoconch has been found in a recently dead shell. Spermathecal duct long and simple, with a spherical spermatheca. Vas deferens attached above the brood chamber, terminating in a characteristic inflated portion with a short blind diverticulum; penis simple, expanded distally. Penial retractor muscle terminal in attachment. Internally there are two main ridges running the length of the penis and two less pronounced ones in the distal portion. The penis is ornamented with small, irregular papillae.

*Distribution*: Silhouette; Mt. Pot a Eau, Mt. Dauban, Jardin Marron, *Pisonia sechellarum* forest.

*Material studied*: 10 specimens collected by the Oxford University Silhouette Expedition 1990 (Nature Protection Trust of Seychelles collection: M/G/S/10.1, and syntypes of *Discus serratus* and *Priodiscus martensi* in the British Museum (Natural History). Specimens in the Musee Royale de l'Afrique Centrale (MRAC 798.864)



Fig. 1. Shells of  
A. *Prodiscus costatus*  
B. *P. spinosus*  
C. *P. serratus*  
scale bar = 1 mm



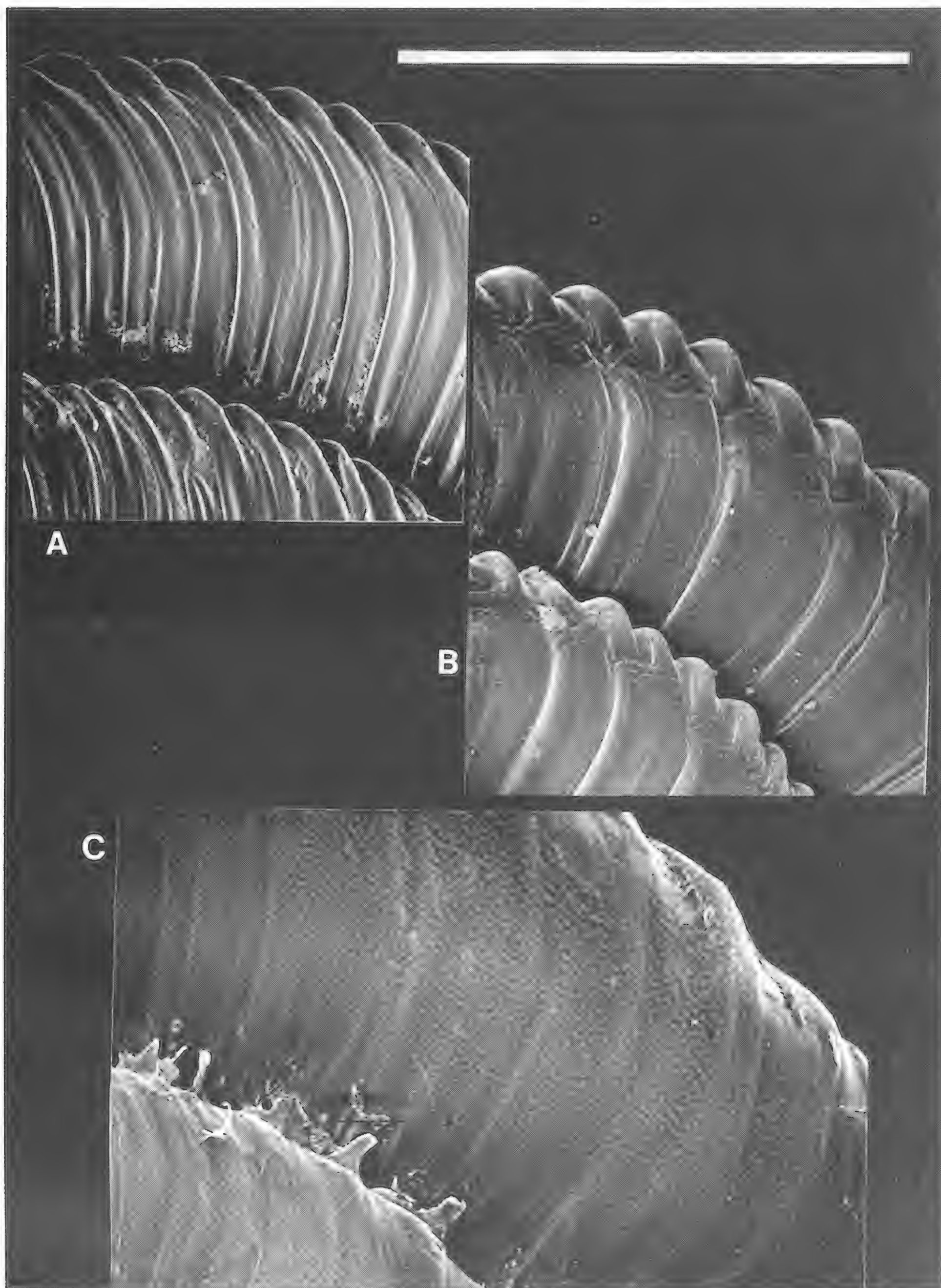


Fig. 2. Details of the shells of  
A. *Prodiscus costatus*  
B. *P. serratus*  
C. *P. spinosus*  
scale bar = 1 mm



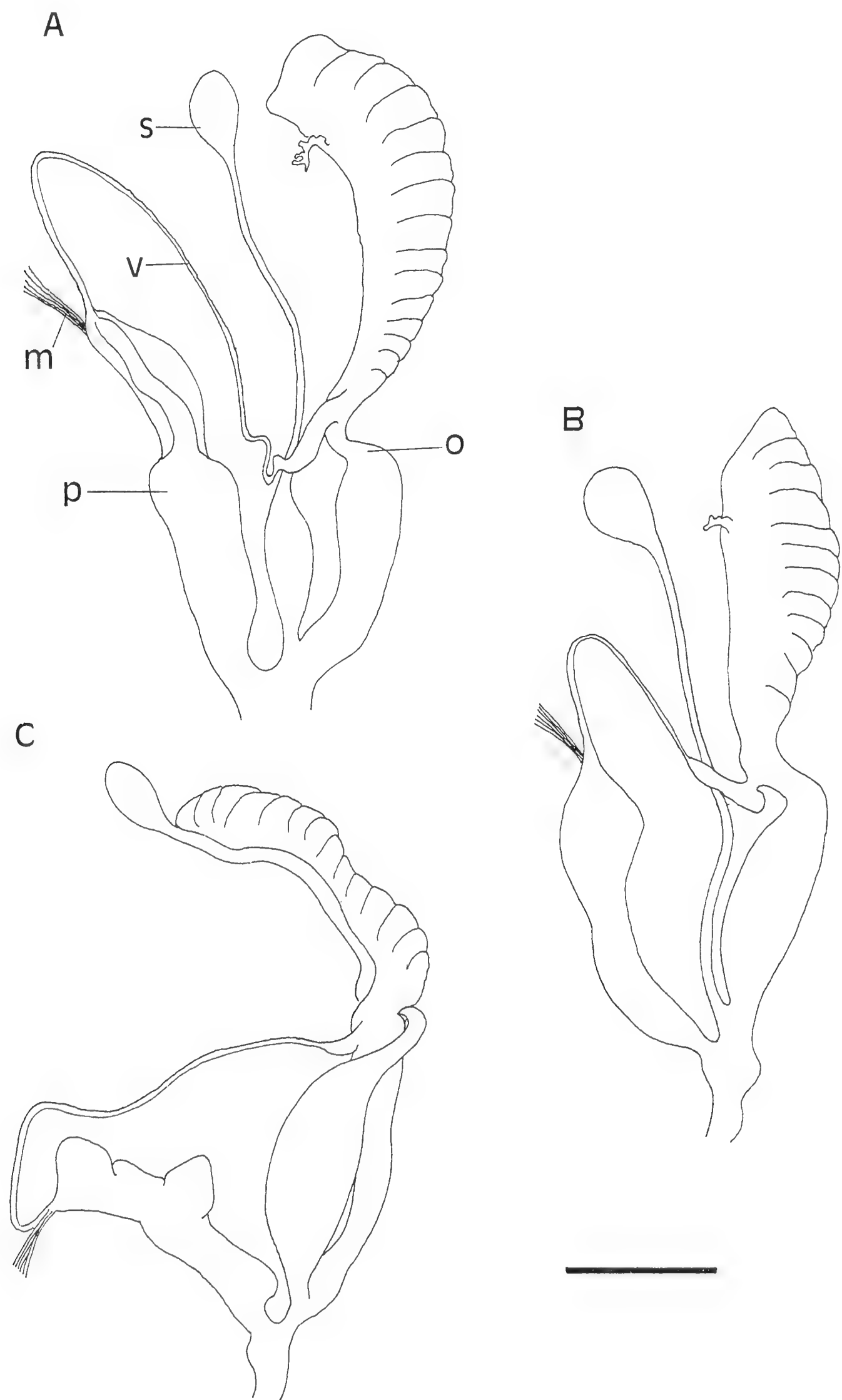


Fig. 3. Reproductive anatomy of  
A. *Prodiscus costatus*  
B. *P. serratus*  
C. *P. spinosus*  
scale bar = 1.5 mm  
Key: m = penial retractor muscle, p = penis, s = spermatheca, so = spermoviduct, v = vas deferens

Notes: The specimens described above are identifiable as the species described as *P. serratus* by Adams by comparison with Adams's illustration, description and the type specimen. Sykes's *P. martensi* illustrations and description also refer to *P. serratus* as study of the original specimens confirms.

**P. spinosus** n. sp.

*Shell* (Fig 1B & 2C): Shell of 4.5–5 whorls and one nuclear whorl, dull, often coated with mud. Most specimens are worn, with a white or yellow tinge. Discoidal, very strongly keeled, regularly ribbed on the first 1–2.5 whorls the remainder with regular growth ridges numbering  $6\text{ mm}^{-1}$  and projecting at the keel and sutures for up to 1 mm, forming irregular curved narrow spines. In some specimens most spines are broken off, the bases remaining are distinct from the rounded ridges of *P. serratus* and the appearance of an elongated keel remains. There are usually some spines retained on the other whorls. Underside with only occasional very irregular growth lines. Umbilicus broad and deep, occupying 25% of the underside of the shell. The thin colourless periostracum is usually detached.

*Dimensions* (mm):

Height	3.2	2.8	2.7	2.5	2.4
Diameter	5.7	5.6	5.0	4.4	3.9
(holotype)					

*Body*: The body is a dull light yellow.

*Anatomy*:

*Radula*: Formula = 43 + 0 + 43. The teeth are long, very fine and S-shaped, indistinguishable in shape from those of *P. costatus* (Fig. 4). The fine points of the central 15–21 teeth on each side are broken off, forming blunt, linear teeth. The teeth are up to 0.044 mm long.

*Reproductive anatomy* (Fig. 3C): Spermoviduct simple in the specimen dissected; vas deferens attached half way up with an inflated terminal portion, without a diverticulum. Spermathecal duct inflated in its lower portion and longer than in *P. serratus*, spermatheca avoid. Penis irregular in outline, having central and terminal enlarged sections; penial retractor muscle terminally attached; internal penial ornamentation consisting of three converging ridges and numerous papillae measuring  $0.022 \pm 4.32 \times 10^{-3}$  mm.

*Distribution*: Silhouette; *Pisonia sechellarum* forest, Mon Plaisir.

*Material studied*: Holotype (BMNH 1994131) and 2 paratypes (BMNH 1994132) collected by the Oxford University Silhouette Expedition 1990, August 1990 in British Museum (Natural History). 10 paratypes from the Oxford University Silhouette Expedition 1990 (Nature Protection Trust of Seychelles collection: M/G/S/10.2).

*Notes*: This species is similar to *P. serratus* but is distinguished by its distinctive elongated spines on the keel and slightly flatter shape. The reproductive anatomy differs in the length of the spermathecal duct, and the penis shape and ornamentation. The radula formula differs by 11 teeth on each half row.

This species is very localised, its known range covering 0.5 hectares. Extensive searches have been made of surrounding areas and it appears that it is entirely limited to the *Pisonia sechellarum* forest and the immediate surroundings.

*Etymology*: The specific name *spinosus* refers to the diagnostic spines on the keel.

***Priodiscus costatus*** sp. nov.

*Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Martens & Wiegmann, 1898, Mitt. Zool. Samml. Mus. Naturk. Berlin **1**, p. 14

*Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Sykes 1909, *Trans. Linn. Soc.*, **17**, p. 63.

*Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Barnacle 1962, *J. Sey. Soc.* **2**, p. 53.

- Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Lionnet, 1984, *Biogeography and ecology of the Seychelles islands*. p. 240.
- Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Gerlach, 1987, *The land snails of Seychelles*. p. 6.
- Priodiscus serratus* sensu Martens & Wiegmann non (Adams) Tillier, 1989, *Malacologia* **30**. p. 71–72.

*Shell* (Fig 1A & 2A): Shell of 5–5.5 whorls, one nuclear, dull, almost clear on the last whorls but dull grey or brown on the apical 3; discoidal in immature specimens, becoming sub-conical in older shells. Dense ( $15 \text{ mm}^{-1}$ ) radial ridges on all whorls, continuing on the underside where alternate ridges are especially pronounced, projecting slightly at the keel. Umbilicus very broad and deep, covering 25% of the underside of the shell. Thin brownish periostracum usually worn off most of shell, being detectable only near apex.

Dimensions (mm):

Height	4.6	4.2	4.1	2.9	2.5	2.2
Diameter	7.9	7.5	7.3	5.6	5.1	4.5

(holotype)

*Body*: The body is very pale yellow, the mantle is orange in some specimens.

*Anatomy*:

*Radula*: Formula = 42 + 0 + 42. Teeth elongated, very fine and S-shaped (Fig. 4), maximum width 0.004 mm and up to 0.06 mm long; central 13–22 teeth on each side broken and worn smooth at the base of the fine curving cone (Fig. 4), leaving a tooth length of 0.03 mm. The extreme elongation of the teeth suggests that *Priodiscus* is adapted to a diet of small soft-bodied invertebrates.

*Reproductive anatomy* (Fig. 3A, 5): The anatomy of this species has been described previously (Martens & Wiegmann 1898, Tillier 1989) and is figured in Tillier (1989). Base of sperмовидuct enlarged into a brood chamber, vas deferens terminally inflated but without a diverticulum; spermatheca duct inflated at base and spermatheca spherical. Penis short and broad with a narrow terminal portion contained within a distinct sheath; retractor muscle attached to tip of sheath. The previously published accounts fail to note the presence of any penial ornamentation in the species. In *P. costatus* this consists of a regular arrangement of conical papillae, without ridges. These papillae may have some orange pigmentation and in one specimen bore a close resemblance to the hard spinules of streptaxids. Three distinct regions can be recognised; the terminal portion contains small papillae of  $0.016 \pm 6.04 \times 10^{-3} \text{ mm}$  ( $n=10$ ), the middle section larger ones of  $0.036 \pm 9.22 \times 10^{-3} \text{ mm}$  ( $n=10$ ) and the lower section contains papillae of  $0.023 \pm 5.27 \times 10^{-3} \text{ mm}$  ( $n=10$ ).

*Distribution*: Mahé; Morne Blanc, Morne Seychellois, La Reserve, Cascade, Copolia, Mare aux Cochons, Morne Sebert, Montagne Planeau. La Digue.

*Material studied*: Holotype (BMNH 1994130) collected at La Reserve, Mahé in July 1993 in British Museum (Natural History), 10 paratypes from La Reserve and 5 from Morne Blanc in the collection of the Nature Protection Trust of Seychelles (M/G/S/10.3).

Specimens labelled *P. serratus* from Percy Sladen Memorial expedition, Sykes labelling, from Mahé (in British Museum (Natural History)).

Specimens from Mahe and La Digue in the collection of the Musée Royale de l'Afrique Centrale (MRAC 798.852, 798.873 & 798.965).

*Notes*: The specimens studied fit with Sykes's remarks for the Mahé specimens: 'may be readily separated by its well marked sculpture over the whole of the shell' (Sykes 1909). The form above is indistinguishable from the shells Sykes labelled as *P. serratus* from Mahé.



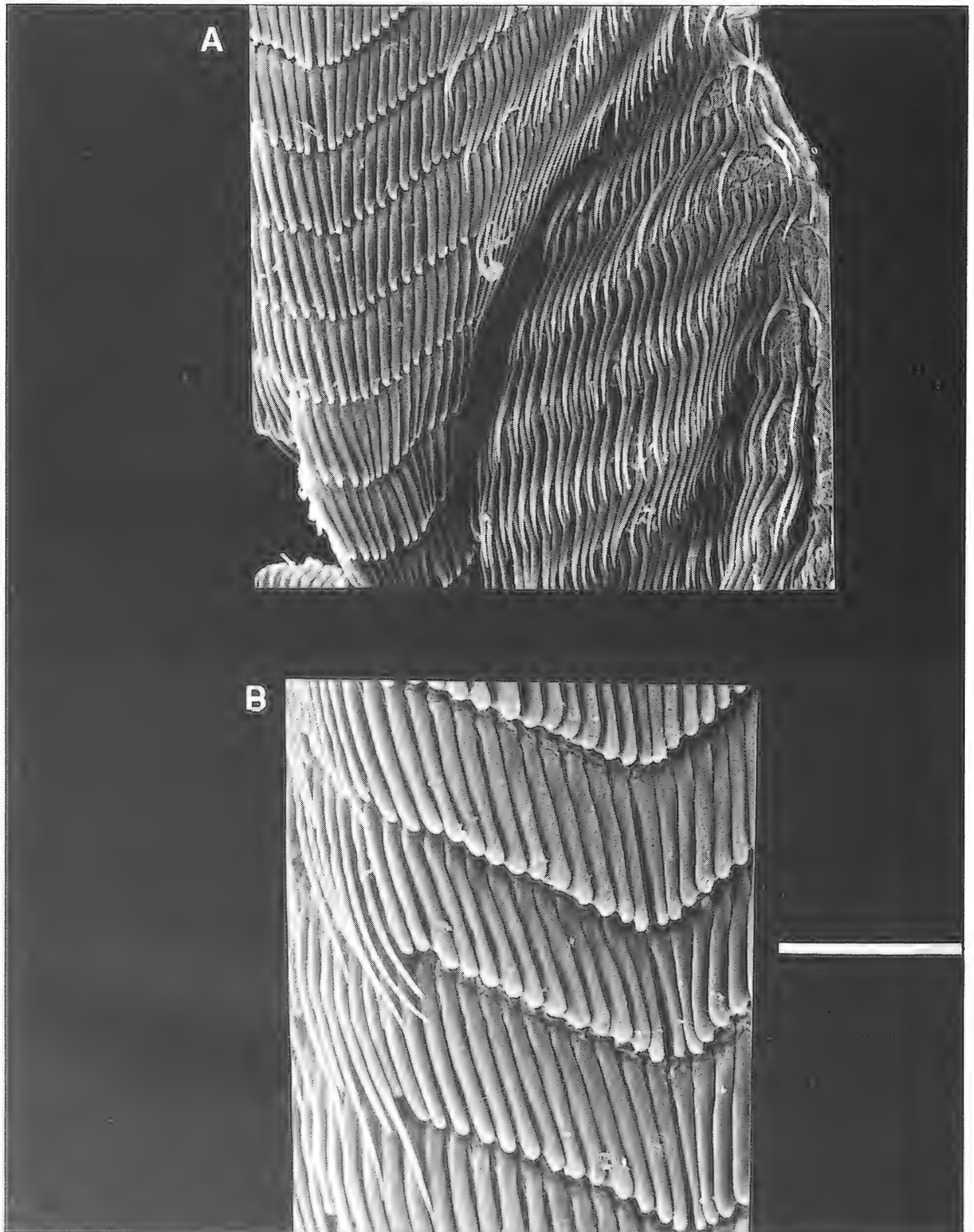


Fig. 4.  
A. Radula of *Prodiscus costatus*  
B. detail showing worn central teeth  
scale bar A = 0.1 mm, B = 0.05 mm

*P. costatus* differs from the other species in its higher adult shell, juveniles have the general discoidal shape of *Priodiscus* species but all stages show the very distinctive dense, regular ribbing on both upper and under surfaces. The radula differs by 10 teeth per half-row from

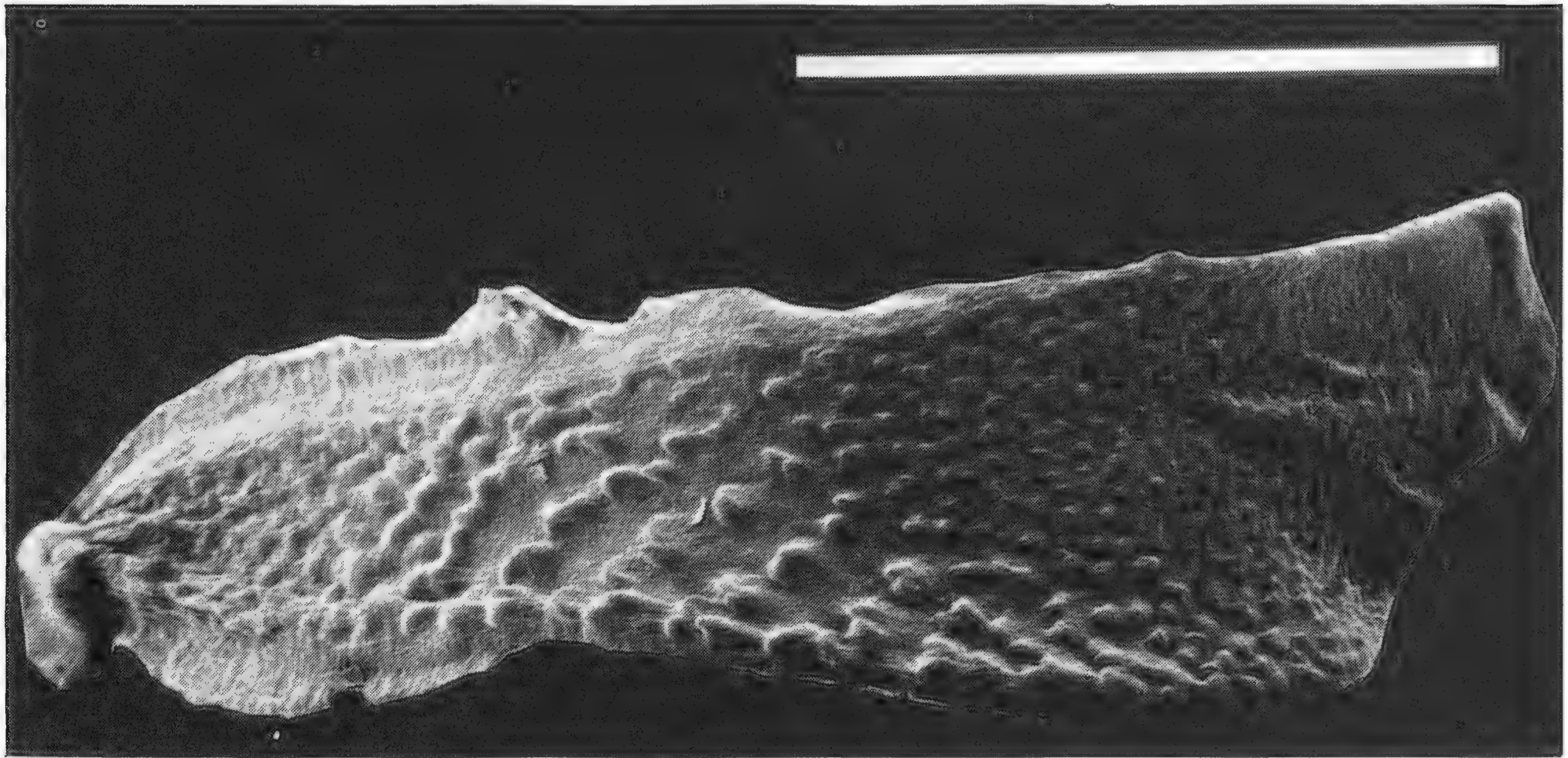


Fig. 5. Penial armature of *Prodiscus costatus*  
scale bar = 1mm

*P. serratus* and by 1 from *P. spinosus*. The penis structure differs markedly from the other two species.

*Etymology*: The specific name *costatus* describes the distinctive ribbed sculpture of the shell.

The distinguishing features of the three species are listed below:

- P. serratus*: Flattened discoidal shell with radial ridges. The keel is finely serrated, the underside lacks regular sculpture. Radula formula  $32 + 0 + 32$ . Vas deferens with a blind diverticulum. Penis simple in shape and ornamented with small papillae and ridges.
- P. spinosus*: Flattened discoidal shell with regular radial ridges. The ridges extend beyond the keel giving a spiny appearance. The underside lacks regular sculpture. Radula formula  $43 + 0 + 43$ . Vas deferens without diverticulum. Penis complex in shape with small papillae and ridges.
- P. costatus*: Depressed conical discoidal shell. Sculpture mostly comprised of coarse growth lines which occur on both sides of the shell. Keel not serrated or spiny. Radula formula  $42 + 0 + 42$ . Vas deferens without diverticulum. Penis complex in shape with numerous papillae but no ridges.

With the exception of *P. costatus* the species described above have very limited ranges (as noted in the case of *P. spinosus* the habitat in which the species is found covers a mere 0.5 hectares) and consequent low population sizes. The rarity of these species means that the collection of further live material should be strongly discouraged.

## DISCUSSION

At present the systematic position of *Priodiscus* is uncertain. Its original placing in the Streptaxidae (Martens & Wiegmann 1898) has been superceded by Thiele's classification of the genus in the Rhytididae (Thiele 1931). Thiele separated the Rhytididae from the Streptaxidae on the basis of their more discoidal shells, the presence of a greenish



periostracum, absence of a central tooth in the radula, ovoviviparity, the absence of a penial sheath and penial spinules. Of these characters the radulae of both families are notably similar (Verdcourt 1951) with the absence of the central tooth also being found in some Streptaxidae (Martens & Wiegmann 1898) whilst such a tooth is present in the rhytidid *Natalina* (Watson 1934), the periostracum is variable in streptaxids and ovoviviparity is found in some streptaxids (Berry 1962). Early errors in assigning species to these two families were noted by Pilsbry (1991).

Tillier (1989) discussed the position of *Priodiscus* on the basis of anatomical dissections, questioning its inclusion in the Rhytididae. This discussion concentrated on characters of the digestive, excretory and nervous systems, of particular importance were the arrangement of the ganglia, the structure of the ureter and the kidney lamellae. The ganglion arrangement, specifically the presence of long parieto-pleural connectives, is evidence in favour of a Streptaxid relationship. The closure of the ureter as far as the pneumostome would exclude the genus from the Rhytididae but could allow inclusion in the streptaxidae. The absence of uterine tube loops between the renal pore and the kidney excludes *Priodiscus* from the Rhytididae according to Tillier's definition of the family. The restriction of internal lamellae to the pulmonary surface of the kidney indicates a relationship with the Oleacinidae. The presence of a rostrum also suggested affinities to the Oleacinidae (Tillier 1989), however, this is also present in some streptaxids (pers. obs.).

The published studies of *Priodiscus* have considered all anatomical characters with the exception of the reproductive system. Dissections of the genitalia undertaken for the species descriptions above shed some light on the phylogeny. These were compared with published accounts of the genitalia of the two families (Berry 1962, Martens & Wiegmann 1898, Murdoch 1901, Watson 1934, Woodward 1895) and with specimens of Streptaxidae from Seychelles and Rhytididae in the University Museum of Zoology, Cambridge. There are significant differences in the genitalia of the two families. The Streptaxidae may possess a penial sheath to which the retractor muscle always attaches terminally whereas there is no sheath in rhytidiae and the retractor muscle half-way up the penis, the Rhytididae also possess an epiphallus. Most streptaxids have penial ornamentation of hard spinules; rhytidis have a variable arrangement of papillae. The penial ornamentation in both families is highly variable and some streptaxids have papillae instead of spinules (Berry 1962). In Seychelles there are two forms of one streptaxid, *Streptaxis souleyetianus* (Petit), which differ in size and the possession of spinules or papillae (pers. obs.) (Fig. 6.). A wide range of papillae shapes are found in the Rhytididae, but not spinules. A range of rhytidid papillae are shown in Fig. 6. from specimens of *Natalina queketiana* (Melvill & Ponsonby), *Paryphanta hochstetteri* (Pfeiffer) and *Apera* sp. in the University Museum of Zoology, Cambridge.

This overview allows the streptaxids to be separated from the rhytidids on the basis of the following characters:

	Rhytididae	Streptaxidae	<i>Priodiscus</i>
long parieto-pleural connectives	—	+	+
gastric pouch dedifferentiated	+	—	—
ureter closed	—	+	+
ureter loops present	+	—	—
kidney long	+	—	—
epiphallus	+	—	—
penial retractor muscle terminal	—	+	+
penis sheath presence	—	+, —	+, —
penis with spinules	—	+, —	—

From this list it can be seen that *Priodiscus* shares all the discriminatory characters with the streptaxids, but is separated from the rhytidids on the basis of long parieto-pleural



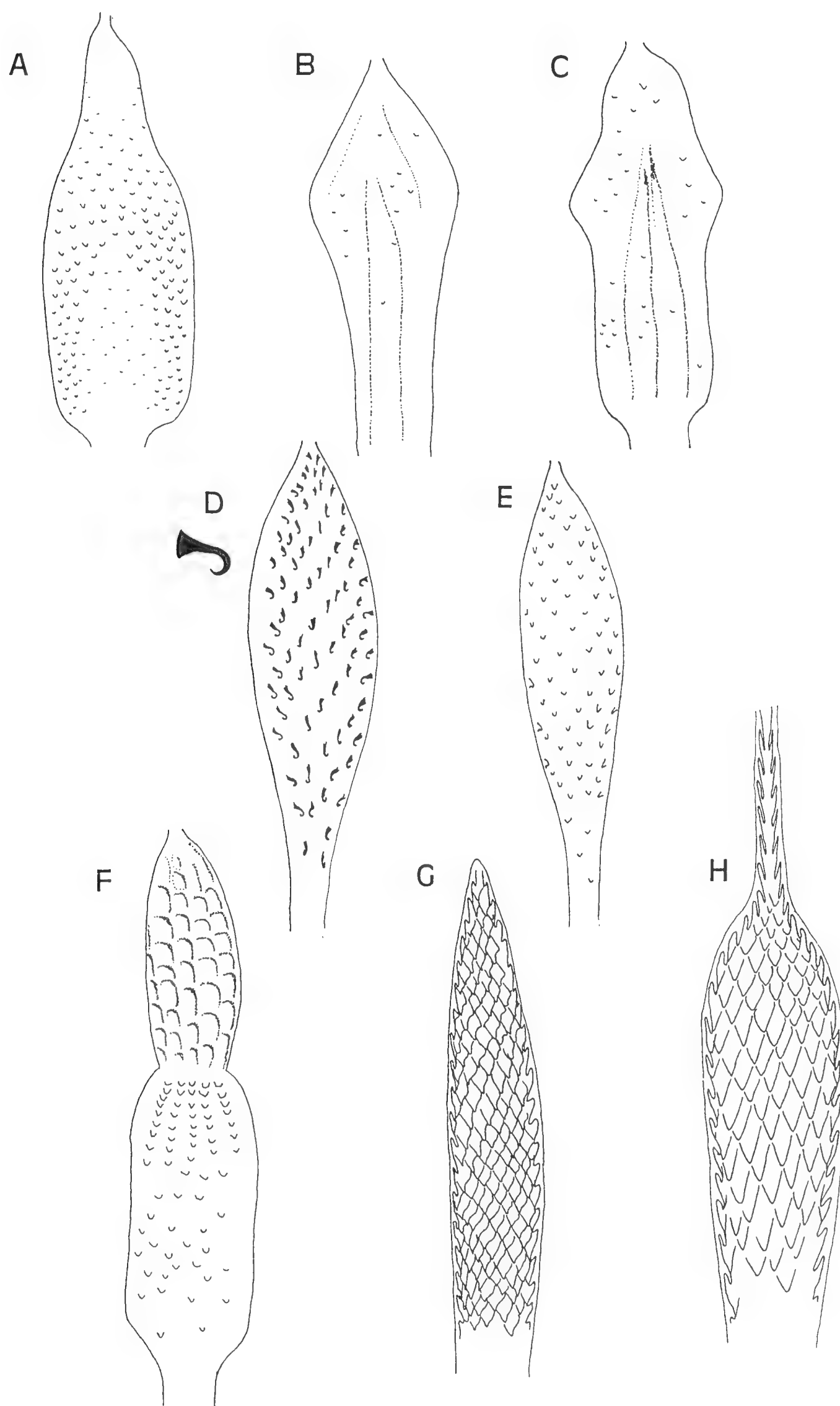


Fig. 6. Penial armature of

A. *Prodiscus costatus*

B. *P. serratus*

C. *P. spinosus*

D. *Streptaxis souleyetianus* (large form), with detail of spinule

E. *S. souleyetianus* (small form)

F. *Natalina queketiana*

G. *Paryphanta hochstetteri*

H. *Apera* sp.

connectives, the closure of the ureter, the absence of ureter loops, no differentiation of the gastric pouch, a long kidney, epiphallus absence, the terminal position of the penial retractor muscle and the presence of a penis sheath in *P. costatus*. The single character that it does not share with streptaxids is the presence of lamellae on the internal surface of the kidney, this is the only character uniting it with the Oleacinidae and is probably autopomorphic.

As a result of these comparisons it is clear that *Priodiscus* is not easily classifiable in the Rhytididae. It should be considered to be a member of the Streptaxidae in preference to the alternatives previously suggested.

#### ACKNOWLEDGEMENTS

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# **CORIOCELLA JAYI N.SP. A NEW LAMELLARIID SPECIES (GASTROPODA: PROSOBRANCHIA) FROM REUNION AND MAURITIUS**

W. WELLENS\*

(Accepted for publication, 20th November, 1994)

*Abstract:* *Coriocella jayi* n.sp. is described from five living specimens, four from Reunion and one from Mauritius. This species resembles *Chelyonotus semperi* (Bergh, 1886) and *Coriocella hibyae* Wellens, 1991, but differs from both in its size, number of dorsal bosses, colour and radula.

*Key words:* Lamellariidae, *Coriocella*, Indian Ocean.

## **INTRODUCTION**

During a stay in Reunion (November 1992), Dr Maurice Jay showed me a drawing of a false sea-slug collected on a fossil reef near St. Gilles les Bains. The first specimen was found in May 1991 and a second in July 1992. My wife found two specimens of the same species on the 5th and 7th November at a site referred to as “le platier de Grand-Fond”. During a visit to Mauritius in October 1993, my wife found a specimen of the same species on the west coast of the island in the village of Flic en Flac. At first glance the dorsal bosses of these specimens were reminiscent the lamellariid species *Chelyonotus semperi* from Indonesia and the Philippines and *Coriocella hibyae* from the Maldives. The specimens were all captured alive, during the day, near the shore in excavations of the reef at a depth of about 40 cm.

## **DESCRIPTION**

### ***Coriocella jayi* n.sp.**

#### *Material examined:*

The five specimens were preserved in 5% formaldehyde and after 3 weeks transferred to 70% ethanol. The internal shell was studied by X-Ray photographs. All measurements were made with callipers.

Holotype: 1 specimen (IG No 28030/2) from Le Platier de Grand Fond, St. Gilles Les Bains, Reunion; coll. M. Jay, xi. 1992.

Paratypes: 3 specimens (IG No 28030/1/3/4) as holotype. 1 specimen (IG No 28030/5) from Fic en Flac, west coast of Mauritius.

Specimen number 28030/4 was used for dissection. All material is deposited in the Kononklijkk Belgisch Instituut voor Natuurwetenschappen (K.B.I.N).

*Measurements:* Table 1.

\* K.B.I.N., Malacology Section, Vautierstraat, 29 B–1040 Brussels Belgium.



TABLE 1

Measurements of the 5 specimens of *Coriocella jayi*, in mm, and indication of sex.

Specimen	Sex	length	Animal breadth	height	Foot length	Foot breadth	Shell max. diameter
1	female	34	18	12	19	5	12
2	male	33	17	15	13	4	13
3	male	30	20	14	11	4	11
4	female	28	16	9	17	8	11
5	male	28	15	11	14	4	12

*Body form:* The holotype (figs. 1 and 2) is spool-shaped with a beige-brown dorsum. Much of the dorsum is occupied by six cylindrical bosses of approximately equal diameter, but the central boss, is higher than the others. The two anterior bosses are the smallest. The four lateral bosses protrude over the edge of the mantle. The two tentacles are each 4 mm long, with a black eye in the middle of the lateral edge. The surface of the mantle and the bosses are divided into irregularly vaulted fragments, with darker brown margins\*. The ventral surface of the mantle is very light beige. The foot is approximately half the length of the animal and had a darker brown colouration (fig. 3).

*Internal shell:* The general form of the auricular shell (specimen 4) is comparable with the shell of *Chelyonotus semperi* and *Coriocella hibyae* (Wellens 1991 fig. 2). The maximum diameter is 11 mm. A periostracum is present and growth lines are clearly visible. The shell is transparent and white.

*Anatomy:* The penis (specimen 4) has a length of 4 mm and a maximum width of 1 mm. It projects behind the right side of the head. The external end of the vas deferens protrudes 0.8 mm beyond the penis tip. At the opposite end of the male duct is enclosed in the body wall (fig. 2 in Wellens 1991 and photo 5).

The jaws (specimen 4) have a length of 2 mm and a width of 1.5 mm (photo 6).

*Radula:* (specimen 4) length 15 mm; width: 0.6 mm. There is a reduced taenioglossate radula of formula 1–1–1. Five rows of teeth were counted for 1 mm of radula length. The rows form a distorsion of about 20° with the longitudinal axis of the radula (photo 7). The rachidian has a height of 300 µm and a base of 230 µm; the left leg is more developed than the right one. The top of the rachidian bears 4 big and 5 smaller denticles on both sides of the upper third. They are equidistant from each other (photo 8/9). The right and left lateral teeth have similar shapes. Their maximum width is 200 µm and the total length 600 µm; half of the length is formed by a central ridge which projects externally under an angle of 130° as a “canine tooth”. The external side of this projection bears 17 small denticles, the internal side only 4 but larger ones (photo 10).

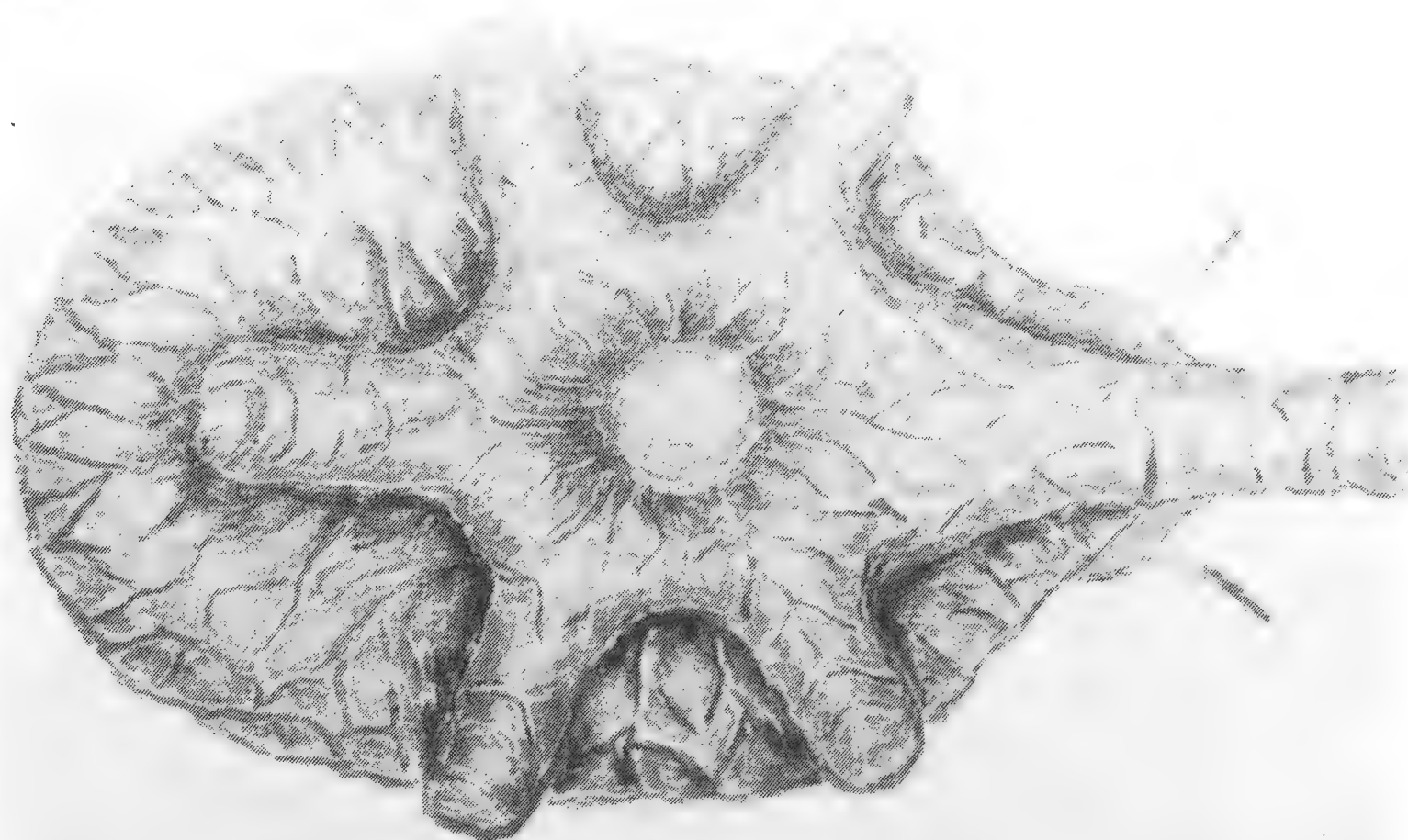
*Etymology:* *Coriocella jayi* is named after my colleague Dr Jay, who was the first to find this species.

## DISCUSSION

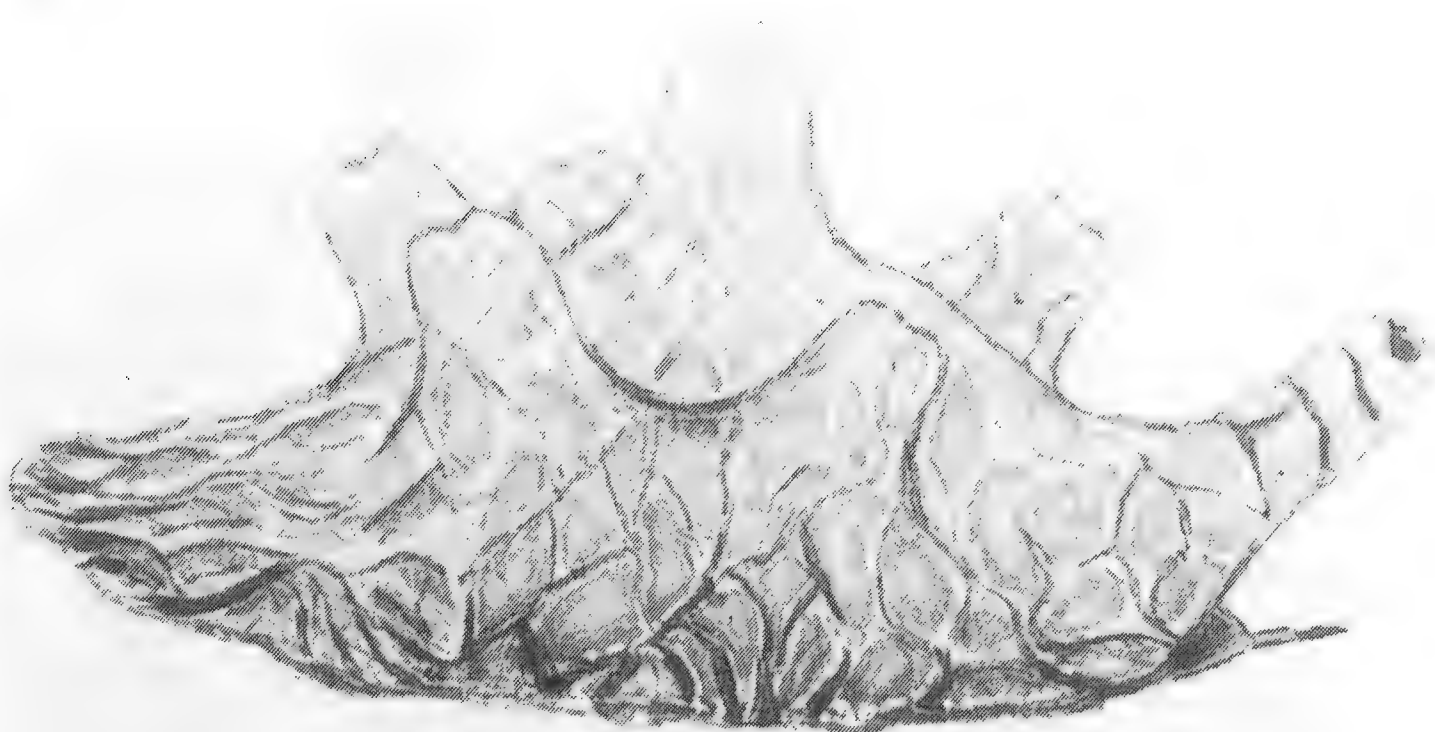
In distinguishing species belonging to the Lamellariidae, dorsal bosses are thought to be diagnostic. A lamellariid species from Ras Mohammed (Gulf of Aqaba) was deposited in the

\* These polygons urged Swainson (1840) to compare them with the back of a tortoise and to create the figurative name *Chelinotus*. In 1846 Herrmannsen emended *Chelinotus* to *Chelyonotus* for etymological reasons: *χελμς* thorax; *νωτος* tergum.

1



2

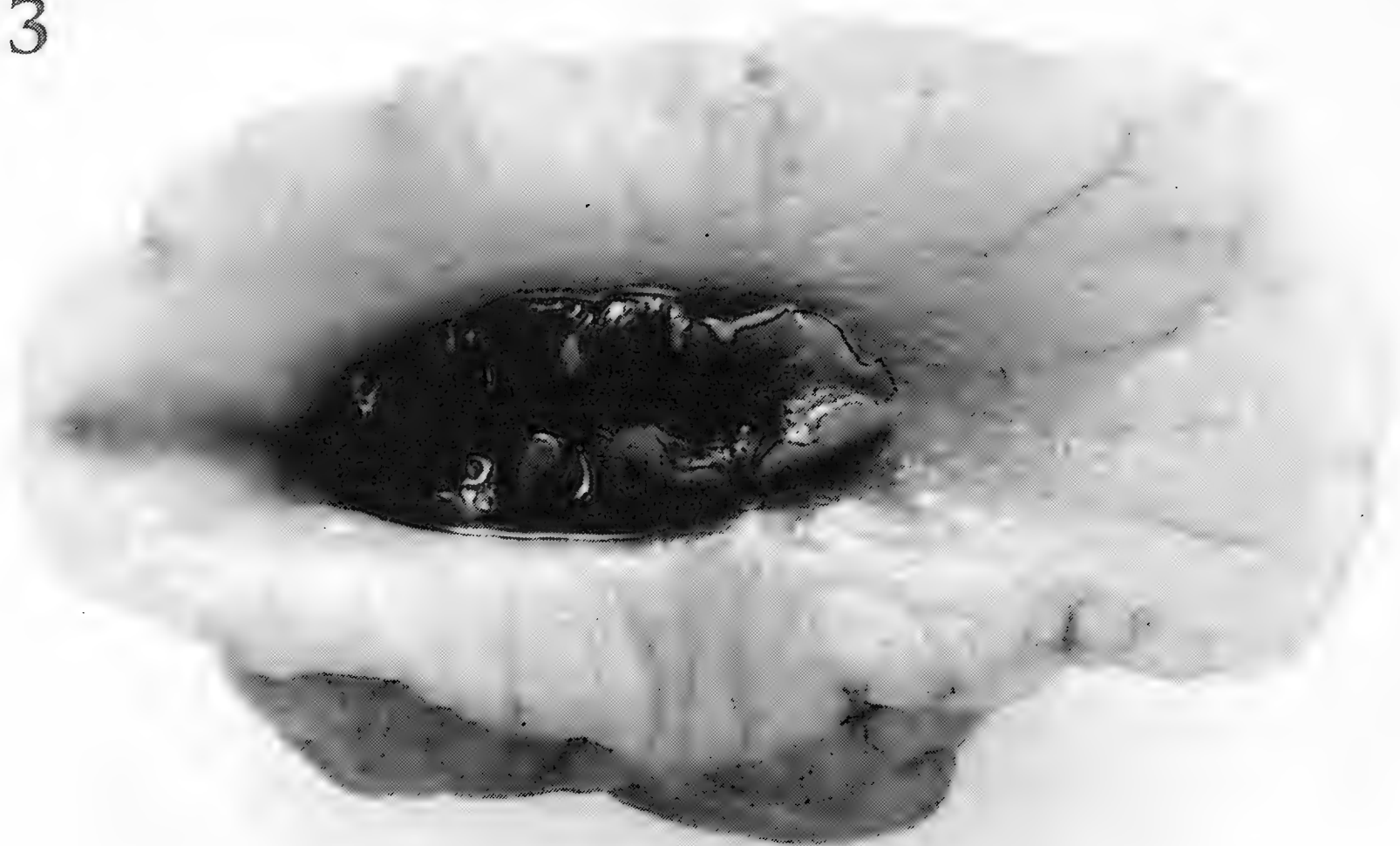


Figs. 1 & 2. Drawing of *Coriocella jayi* – the living animal. Holotype IG 28030/2. Fig. 1 dorsal view; Fig. 2 lateral view.

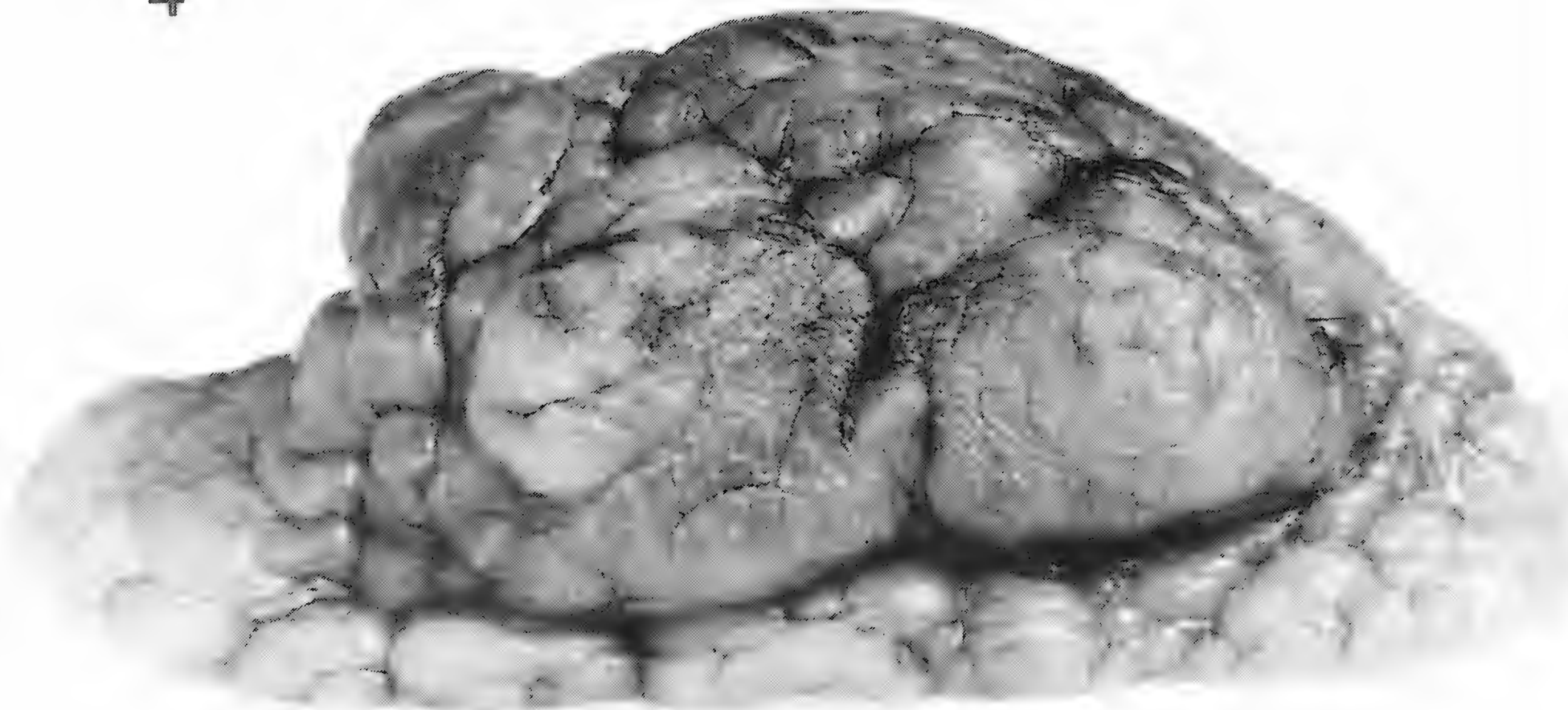
collections of the K.B.I.N in 1988. It was found alive by Mr. E. Wils and showed, before fixation, two rounded bosses on the posterior third of the dorsum. It was yellow-beige and mantle fields were absent (pers. obs.; table 2).

The collections in Brussels also contain seven lamellariid specimens with three dorsal bosses: four from Reunion and three from Mauritius which are assigned to *Coriocella nigra* Blainville, 1824. Species with five bosses are less rare: the K.B.I.N. collections contain several specimens of *Coriocella hibyae* Wellens, 1991, from the Maldives and five specimens of

3



4

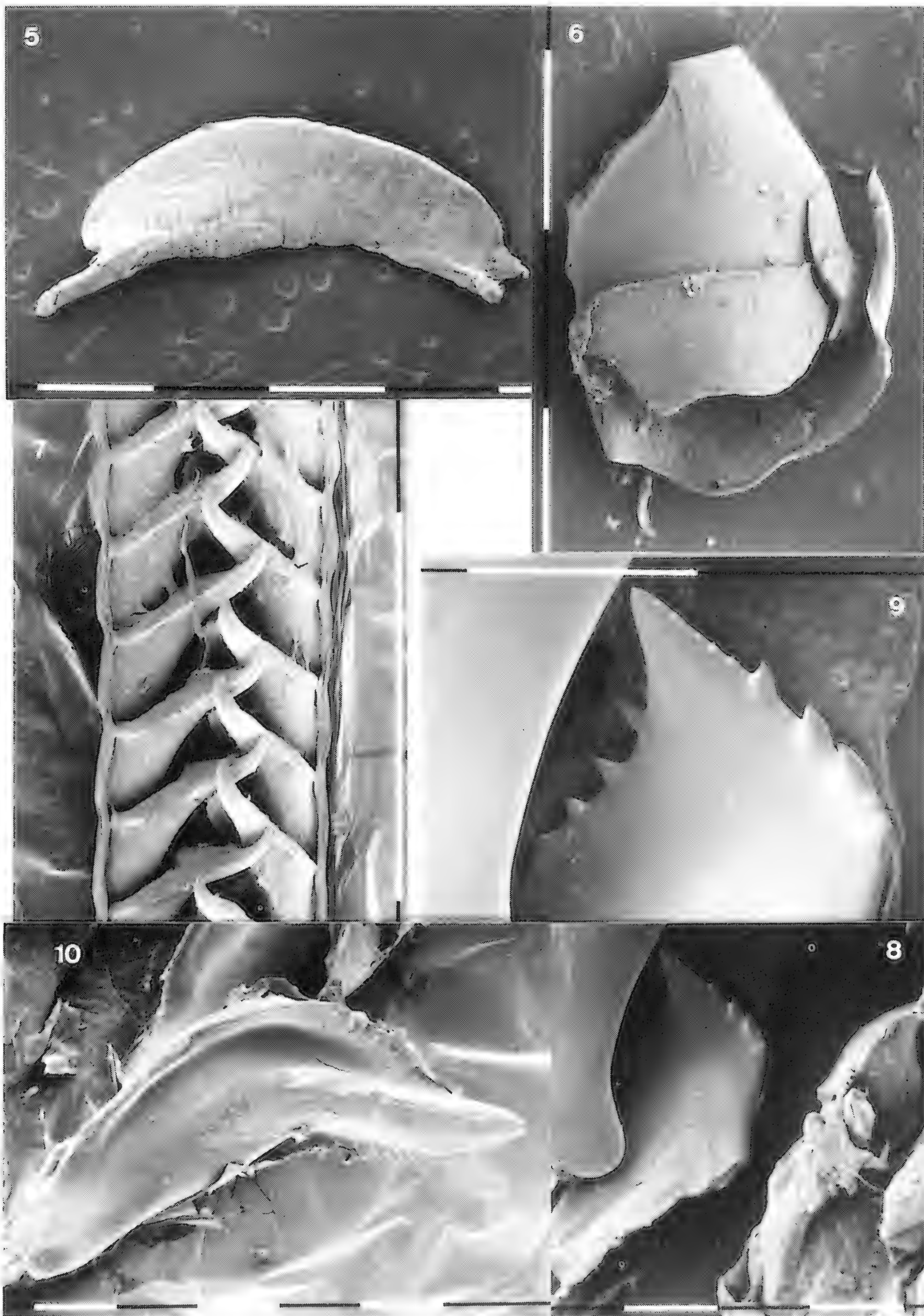


Figs. 3 & 4. Photographs of *Coriocella jayi* preserved in 70% ethanol. Fig. 3 ventral view; Fig. 4 lateral view.

*Chelyonotus semperi* Bergh (1886) four from Southeast Maluku and one from Papua New Guinea (fig. used by Wellens 1991). We found in the Red Sea (1992 and 1993) near Safaga three specimens with five dorsal bosses, four arranged as a square and one placed centrally (pers. obs.). They resemble the drawing of the lamellariid specimen found by Vayssi re (PL XI fig. 165, 1912) from the Bay of Tadjourah (Gulf of Aden) and called *Chelyonotus niger* Bergh 1875 (synonyms: *Lamellaria nigra* Blainville and *Chelyonotus tonganus* var. Berghi). It is likely that the lamellariid specimen described by E. Marcus (1986/87) from the Gulf of Aqaba belongs to the same species.

Although *Coriocella jayi* has six dorsal bosses, it closely resembles *C. semperi*, because of the division of the back into separate fields. Some specimens of *C. semperi* reach 65 mm in length,



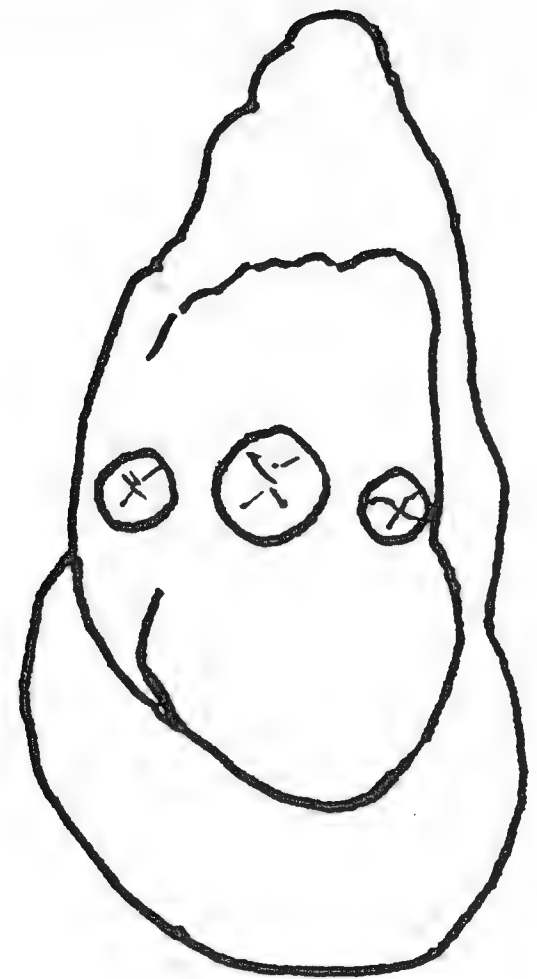


Figs. 5–10. Scanning electron micrographs of *Coriocella jayi*. Fig. 5 Penis, scale bar = 1 mm. Fig. 6 Jaws, scale bar = 1 mm. Fig. 7 Part of the radula, scale bar = 1 mm. Fig. 8 Rachidian tooth, scale bar = 100  $\mu$ m. Fig. 9 Tip of rachidian tooth, scale bar = 100  $\mu$ m. Fig. 10 Lateral tooth, scale bar = 100  $\mu$ m.

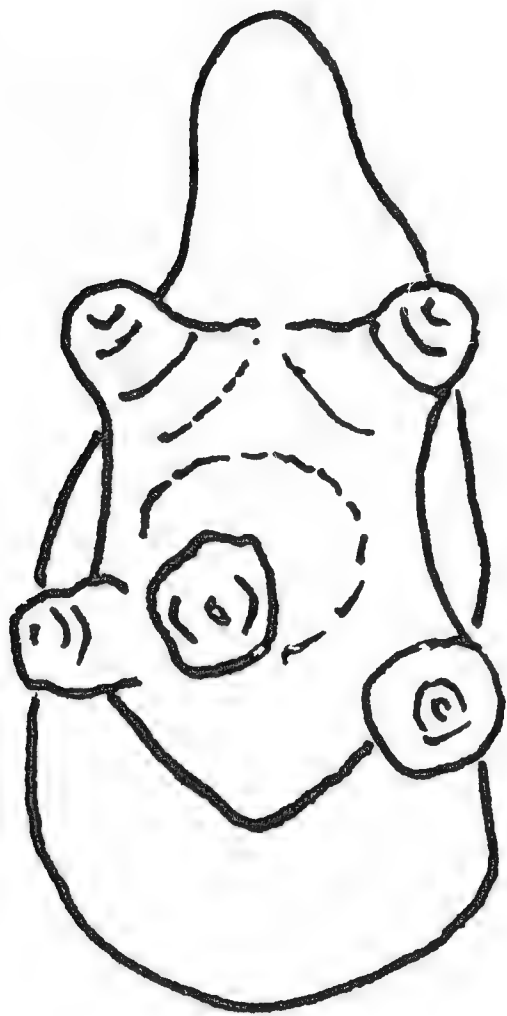
but the maximum length of our specimens of *Coriocella jayi* is only 37 mm. However, the ratio between length and breadth of the two species is the same. Additionally the ratio between the complex of the bosses is comparable, except for the boss in the middle of the dorsum of *C.*



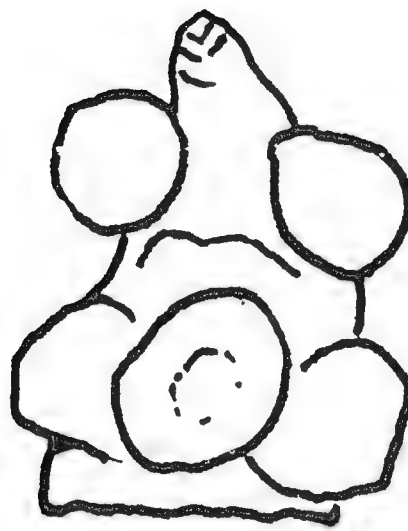
*C. spec. Gulf of Aqaba.*



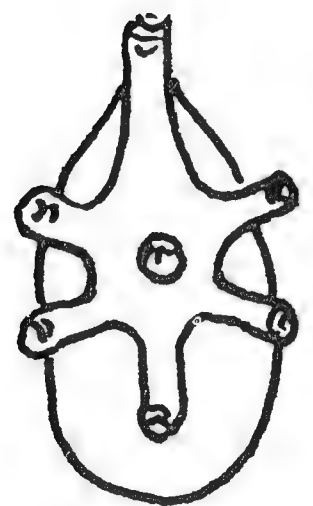
*C. nigra.*



*Chel. semperi.*



*C. hiabyae.*



*C. jayi.*

Scale bar  $\longleftrightarrow$  10 mm.

Fig. 11. Comparative size life drawings of five different species of *Coriocella* and *Chelyonotus*.

*jayi* which is situated on the central longitudinal axis of the animal between the central boss and the posterior end. In addition to the tabulated information on the dorsum of the five different species (Table 2), actual size drawings are presented to exemplify size, form, location and configuration of the bosses (fig. 11). The ratio between the maximum lengths of the shells of *C. jayi* and those of *C. semperi* is the same, approximately 3/1. The form of the location of the penis of *C. jayi* is comparable with the drawing of the penis of *C. semperi* by Bergh, (1886, Tafel O fig. 2).

The form of the jaws of *C. jayi* is comparable with the drawing of Bergh (1886, Tafel N fig. 16).

In table 3 the middle third of the radula of *C. jayi* is compared with the middle third of the radula of *C. semperi* (plate 8 in Wellens 1991). There are two obvious differences, the number

WELLENS: *CORIOCELLA JAYI* N.SP. A NEW LAMELLARIID SPECIES

TABLE 2

Characteristics of the dorsum of five species.

SPECIES		number	BOSSES form	after death	COLOUR	MANTLE FIELDS	N° SPECIMENS EXAMINED
A	Lamellariid species from Gulf of Aqaba.	two	round	yes	yellow beige	no	1
B	<i>Coriocella</i> <i>nigra</i> Blainville, 1825	three	round	no	black	yes	7
C	<i>Chelyonotus</i> <i>semperi</i> Bergh, 1886	five	cylindriform	yes	black	yes	27
D	<i>Coriocella</i> <i>hibyae</i> Wellens, 1991.	five	round	yes	dark- green	no	7
E	<i>Coriocella</i> <i>jayi</i> , sp. nov.	six	cylindriform	no	beige brown	yes	5

TABLE 3

Comparison between one radula of *Coriocella jayi* (specimen 4) and four radulae of *Chelyonotus semperi* and *Coriocella hibyae* with average measurements of 14 rachidians and 12 lateral teeth. All measurements in mm.

Species	<i>C. jayi</i>	<i>C. semperi</i>	<i>C. hibyae</i>
Body size	28	40–55	40–55
Radula			
length	15	17,25	31,8
breadth	0,6	0,92	1,2
number of teet rows per mm.	5	3,9	2,3
distorsion of rows with longitudinal axis	±20°	±20°	20°–40°
Rachidian			
basis	0,230	0,257	0,450
height	0,300	0,215	0,257
denticles	4 big 5 small	4 big 6 small	10 big
Lateral teeth			
breadth	0,200	0,233	0,274
height	0,600	0,722	1,0
denticles internal	4	6	6
external	17	20	20
angle of canine projection	±130°	±130°	±130°

of teeth rows per cm length of the radula (50 for *C. jayi* and 40 for *C. semperi*), and the rachidian which differs in proportions (the rachidians of *C. jayi* being more slender).

CONCLUSIONS

Although *C. jayi* is quite similar to *C. semperi*, it is clearly distinct on account of its size, the number of bosses, the colouration and the radula. In 1931 Thiele considered that *Coriocella*



*Blainville* (1824) was a synonym of *Chelionotus Swainson* (1840) and of *Chelyonotus Bergh* (1853), because their male duct was enclosed in their body walls which separates *Coriocella* and *Chelyonotus* from the genus *Lamellaria*. Because *Coriocella* is the older name and because our species has the same anatomy, we have assigned our new species to the genus *Coriocella*.

#### ACKNOWLEDGEMENTS

I am indebted to Dr. J. Van Goethem (K.B.I.N) for providing me with working facilities and for supervising this study. Thanks are further due to Dr. M. Jay for the two first specimens of *Coriocella jayi* and the permission to describe this new species. I thank my wife I. Hiby for procuring me three other specimens and for the drawings of the animals. For technical help thanks are due to Mr. J. Cillis (K.B.I.N) and finally I am indebted to Dr. J. Van Goethem and Dr. T. Backeljau for commenting on the manuscript.

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COMMUNICATIONS

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature

The following Applications were published on 30 June 1995 in Vol. 52, Part 2 of the *Bulletin of Zoological Nomenclature*. Comment or advice on any of these applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary (I.C.Z.N.), c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

**Case 2903**  
***Tropidoptera* Ancey, 1889 (Mollusca, Gastropoda): proposed designation of *Endodonta wesleyi* Sykes, 1896 as the type species**

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**Abstract.** The purpose of this application is to conserve the original concept and subsequent understanding of the name *Tropidoptera* Ancey, 1889 for a genus of terrestrial gastropods belonging to the endemic Hawaiian family AMASTRIDAE. The nominal species *Helix alata* Pfeiffer, 1856 was fixed as the type, but this was based on a misidentification and it is proposed that the taxon actually involved be designated as type species; this is *Endodonta* (*Pterodiscus*) *wesleyi* Sykes, 1896.

**Keywords.** Nomenclature; taxonomy; Gastropoda; *Tropidoptera*; *Pterodiscus*; Hawaii.

**Case 2946**  
***Plutoniinae* Bollman, 1893 (Arthropoda, Chilopoda) and *Plutoniinae* Cockerell, 1893 (Mollusca, Gastropoda): proposed removal of homonymy**

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**Abstract.** This application proposes removal of the homonymy between the family-group names PLUTONIINAE Bollman, 1893 (centipedes) and PLUTONIINAE Cockerell, 1893 (slugs), which are respectively derived from the generic names *Plutonium* Cavanna, 1881 and *Plutonia* Morelet in Stabile, 1864. As the centipede name PLUTONIINAE Bollman is the senior homonym, it is proposed that the entire generic name *Plutonia* be used as the stem to form the gastropod subfamily name PLUTONIAINAE Cockerell.

**Keywords.** Nomenclature; taxonomy; Chilopoda; Gastropoda; PLUTONIINAE; PLUTONIAINAE.

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 30 June 1995 in Vol. 52, Part 2 of the *Bulletin of Zoological Nomenclature*. Copies of these Opinions can be obtained free of charge from the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

- OPINION 1805. *Doris grandiflora* Rapp, 1827 (currently *Dendrodoris grandiflora*) and *Doridopsis guttata* Odhner, 1917 (currently *Dendrodoris guttata*) (Mollusca, Gastropoda): specific names conserved .....
- OPINION 1806. *Ammonites nodosus* (currently *Ceratites nodosus*; Cephalopoda, Ammonoidea): specific name attributed to Schlotheim, 1813, and a lectotype designated .....

PETRICOLA LITHOPHAGA IN ENGLAND

A collection of recent molluscan shells made, between the two world wars, by R. H. Moses, is housed in the Haslemere Museum, Haslemere, Surrey. The collection includes two complete shells of *Petricola lithophaga* (Retzius), one from Pravesa, Italy, the other collected alive by Moses from Sandwich Bay, Kent, June 1935. The

determination was checked by J. R. le B. Tomlin and confirmed by myself by comparison with a collection of *P. lithophaga* in the Zoology Department of the Natural History Museum.

The dimensions of the two shells are given in millimetres, Sandwich Bay first, Pravesa in brackets. Length 10.8 (12.4), height 6.9 (9.0), inflation 5.2 (7.0), riblets on each valve 63–67 (38–40). Dried tissue adhering to the inside of the valves of the Sandwich Bay specimen confirm that it was alive when collected. Gert Lindner has figured the species, "Seashells of the World", Blandford Press, p. 244, pl. 61, fig. 18, but the many riblets are not clearly shown. M. Kerney, 1981 (below) refers to "Shell Life", E. Step, p. 138.

Natural History Museum collections show that *P. lithophaga* has a broad distribution. It was collected from Texas by Carpenter and occurs right across the Mediterranean, from 'coast of Spain' to Greece, and into the Black Sea. It is found in the Gulf of Suez and as far east as 'China Seas', thus showing a preference for warm-temperate waters. Examples from the Mediterranean show that *P. lithophaga* bores into hard, grey (?Tethyan) limestone, producing crypts the shape of the shell, and opening to the outside with hour-glass shaped aperatures for the inhalant and exhalant siphons. Mediterranean shells tend to be bigger than the Sandwich Bay specimen: length 27 mm from Malta and Naples, length 19 mm for Algeria. Gert Lindner, p. 244, claims that the range of *P. lithophaga* is "Mediterranean to Britain". Sandwich Bay covers 7 miles (11.3 km) of coast from Deal to Pegwell Bay, most of which is across the outcrop of the Thanet Sands producing a sandy and muddy shore. Since *P. lithophaga* bores into soft to hard rock it is unlikely to have been collected alive along that part of the coast. Chalk outcrops at Pegwell Bay are a more likely habitat and locality.

J. G. Jeffreys, "British Conchology" vol. 2, p. 238, mentions that "... this species has not been authenticated as British, although it is rather common in the Mediterranean and the west of France". He goes on to remark that a specimen in the J. D. Humphries collection of Irish Shells was "... found by him in Cork Harbour but I have reason to believe that it came from a piece of ballast stone".

Michael Kerney in Conchologists Newsletter 1981, no. 79, pp. 348–9, reports finding crypts, with shells of *P. lithophaga* in good condition, in blocks of exotic stone used in the construction of walls in Greenwich. He was able to establish that the stone originated as ballast from Victorian sailing ships. With the near demise of commercial sailing ships in early 20th Century it seems unlikely that the Sandwich Bay specimens were, in 1935, still alive in ballast. More likely, it arrived in ballast during the late 1900s and colonised the Chalk of Pegwell Bay, but may not have survived very cold winters. Use of ballast began to decline around the end of the 19th century as heavy engines replaced sail and lowered the centre of gravity.

Whether or not *P. lithophaga* should go on the British List of marine molluscs, is a matter for the Marine Recorder. But the possibility, that it might still be alive in Chalk outcrops along the S. E. coast, is worth keeping in mind during marine recording field work. A geological hammer would be a useful tool.

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## ANADARA INAEQUIVALVIS (BRUGUIÈRE, 1789) IN THE NORTH ATLANTIC

Several sepcimens of the bivalve *Anadara inaequalvis* (Bruguière, 1789) have been collected during 1993 and 1994 in the intertidal culture parks of *Ruditapes philippinarum* Adams & Reeve, 1850 in the Eo Estuary, Atlantic North coast of Spain.

The importation of commerical bivalves has resulted in the introduction of alien marine molluscs in the North Atlantic coast of Spain (Rolán, E. *et al. Thalassas* **3**: (1985) pp. 29–36). In the Eo Estuary, the Pacific Opisthobranch *Haminaea calidegenita* Gibson & Chia, 1989 has been recently reported (Álvarez, L. *et al. Iberus* **11**: (1993) pp. 59–65).

A possible pathway of introduction of *A. inaequalvis* to Northern Spain could be from Italy. In the years 1900 and 1991, the marine farming company Cultimar S. A. introduced spat of the clam *Ruditapes philippinarum*, of Italian origin, to the Eo Estuary. It is very probable that spat of *A. inaequalvis* were introduced along with *Ruditapes*. Zibrowius (1991, *Mésogée* **51**: 83–107) indicated the presence of *A. inaequalvis* (as *Scapharca inaequalvis*) on the Italian coast. It was first recorded from near Ravenna, northern Adriatic Sea, where it had arrived by accidental ship transport. *Anadara inaequalvis* then rapidly invaded all the Adriatic Sea and reached Sicily, Calabria, Naples and Geneva. Living specimens of *A. inaequalvis* were seen among oyster spat imported to Northeastern Spain from Italy, before release into the local environment (Rolán, E. *et al. Thalassas* **3**: (1985) pp. 29–36, under the name *Scapharca cornea*).

It is difficult to know if there are stable populations of *A. inaequalvis* in the north of Spain. The capture of living specimens during two consecutive years indicates that this species survives in this area. Our specimens are small (less than 36 mm) in contrast to the Mediterranean (81.5 mm of maximum size, Cesari, P. & Pellizzato, M. *Boll. Malacologico* **21**: (1985) 237–274) and thus have not been established for a very long time. Never the less, the high



## COMMUNICATIONS

ecological versatility of this species (Ghisotti, F. & Rinalid, E. *Conchiglie***12**: (1976) 183–195) makes it possible that this species has become established in the North of Spain.

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## REVIEWS

“A Natural History of Shells” by Geerat J Vermeij, 1993. Paperback edition 1995, Princeton University Press, pp 207 and 22 colour plates. ISBN 0–691–00167–7 (pbk). Price in the UK £12.95.

As this fascinating book received excellent reviews when first published in 1993 the aim of this review is to draw attention to its availability as a paperback. Its treatment of shells is based on 3 questions by the molecular biologist, Sidney Brenner, as the author points out – “How does it work? How is it built? How did it evolve?” – so it has 3 parts: “The Rules of Shell Construction: Life in a Dangerous World,” “How Shells Work”; and “The Dimension of Time”.

The book begins by making shell geometry comprehensible, even to the mathematically blind like myself, though in Chapter 2 the reader sometimes has to remember that references to “shell” are to gastropods, and I think that the terms convex and concave are transposed in Figure 2.12. It concludes by discussing the economics of shell construction and maintenance.

In the second part, the chapter on shell mechanics explores the relationship between shell shape, the laws of physics, and the forces to which organisms are exposed and life on the upper shore, in waves and currents, as a swimmer or floater, and on sandy and muddy bottoms. This is followed by chapters on predators and their methods and on the shell as protection, all full of thought provoking and clearly explained points.

Finally, Professor Vermeij examines the dimension of time, beginning with how the changing geography and climate of the last 20 million years has affected the distribution of marine molluscs in tropical, temperate, and polar regions. In his last chapter, “Evolutionary Economics: the Rise and Fall of Adaptive Themes,” he deals briefly with the history of life on earth, the evolution of predators on molluscs, the colonising of sediments and rocks by animals (especially molluscs) and molluscan responses to predation – and goes on to look at the economics of specialisation and the use of shells by organisms after the original builders have died. He ends by comparing the history of the biosphere – as a tale of the economics of resources which shows that economic growth is a rare and temporary conditions – with the human situation, and he points out the danger of reliance on high resource use because of the risk of interruption of supply.

This is a beautifully constructed book which deserves careful reading: thoroughly recommended, especially at the paperback price.

David Long

*Zoogeographical studies on the land Mollusca of the Province of Dalsland (SW. Sweden)*. By Ted von Proschwitz. *Acta Regiae Societatis Scientiarum et Litterarum Gothoburgensis. Zoologica* **15**, 152 pp. Kungl. Vetenskaps- och Vitterhets-Samhället Göteborg. 1994. ISBN 91–85252–53–0.

For many years the Museum of Natural History in Göteborg has undertaken faunistic studies in the Province of Dalsland in SW Sweden. This region is of special interest not only because of its ecological diversity but because it straddles the border between the Boreal and S. Scandinavian regions, a boundary reflected by the northern limit of oak. Moreover, calcareous rocks occur within the Precambrian Dal series in the central and northern parts of the Province and these contribute to the ecological diversity of the region.

This book provides detailed distribution maps for all 73 species of land molluscs known from the Province. Thirteen of these species are regarded as human introductions, the rest are believed to be indigenous. The distributions are shown as ‘dot maps’, rather than ‘grid maps’, and are based on data from 422 localities collected mostly by the author during the 1970s and 1980s. Older data obtained between 1938–1967 is also incorporated. The distribution patterns have been analysed and eight main groups recognized. These local distributions are then discussed in relation to the overall range of each species in Scandinavia. The zoogeographical affinities of the fauna are discussed and full ecological data provided.

Eight species, including *Spermodea lamellata*, *Ena obscura*, and *Balea perversa*, apparently have their northern limit in this part of Sweden, whereas part of the southern range of *Zoogenetes harpa* also falls in this region. From a British perspective there were some surprises amongst the maps. The slug *Arion ater*, so abundant throughout most of the British Isles, was found in only 16.6% of the sites sampled. Moreover *Deroceras reticulatum* occurred in less than 10%, whereas *D. agreste* was found in no less than 11.7% of sites. *Arion circumscriptus* (6%) proved to be surprisingly scarce and far less common than *A. silvaticus* (22.1%). There were twice as many records for *Aegopinella pura* (21.3%) than for *A. nitidula* (9.7%), which in this region is said to be an inhabitant of ‘calciphilous woodland’ (p. 19). *Nesovitrea hammonis* is not unexpectedly the most common and widespread species in Dalsland with *Columella aspera*, *Punctum pygmaeum*, *Euconulus fulvus* and *Clausilia bidentata* all occurring in over 50% of the sites.

The distributional limits for 39 species were accurately mapped and found to coincide with various topographical and geological boundaries, which are also shown on some accompanying maps. Furthermore, land molluscs from ten selected 5 × 5 km squares, which has previously been studied floristically, were analysed statistically and compared with the botanical data.



Dalsland, with an area of only 4136 sq km, is one of the smallest provinces of Sweden and this survey is therefore akin to some of the county tetrad ( $2 \times 2$  km) schemes presently underway in Britain. It will therefore be of considerable interest to those engaged on such projects and to everyone with an interest in the distribution and ecology of land snails. The author is to be congratulated for the sustained mapping over several years and for bringing the results to fruition in such an elegant manner.

R. C. Preece

*Atlante delle Conchiglie Terrestri e Dulciacquicole Italiane* By Tiziano and Vincenzo Cossignani, published by L'Informatore Piceno, Ancona, 1995 pp 1–208, ISBN 88-86070-06-3. Obtainable from Mostra Mondiale Malacologia, Via Adriatica Nord, 240-63012 Cupra Marittima, Italy. Price L.118.000 (£45–47).

Here is a very welcome guide (A4 size) to the shells of the non-marine molluscs of Italy. It is valuable as a gap filler because there is nothing else comparable for Italy or any other southern European country. The book consists of a list of species and subspecies, in taxonomic order, followed by colour plates, mostly photographs, in the same order. These are accompanied by a brief note of the habitat in which each taxon is found, a small inset map showing in which part of Italy it occurs, and an indication of its size range. Localities and dimensions under photographs refer to the shell or shells in the photograph. Appendices cover a reissue of Carlo Alzona's catalogue of "forms" of Italian terrestrial and freshwater molluscs of 1971 (1961 on page 163 is presumably a "typo.", a listing of the taxa covered by this book sorted by region of Italy, some examples of molluscan habitats, a bibliography, and information in German on the South Tyrol. These are followed by an index.

Because of its size, the book would not be suitable as a field guide but it will be invaluable for anyone with mollusc shells from Italy or its surroundings as it contains information not readily available elsewhere. Its strengths lie in the concisely presented data and in its being fully illustrated by colour photographs, supplemented by line drawings from other publications where these are helpful to show smaller species.

There are some weaknesses. Photographs of smaller species tend to be slightly out of focus. Further, because it is concerned with shells, it will not suffice to identify slugs or families where the external appearance or anatomy of the animal is important; this drawback is in part balanced by footnotes pointing out problem areas. Interiors of bivalves are not generally shown. Users of this book should be vectored towards an answer in these cases but should also consult other literature for, for example, Vertiginidae, Virtriniidae, Zonitidae and Sphaeriidae. There also appear to be one or two errors; I am not certain of the shells shown as *Anisus verticulus* on page 53 (they look like part-grown *A. vortex*); on page 67 the photograph captioned *Vertigo substriata* shows *V. antivertigo* and I am not confident of naming the shell called *Vertigo alpestris*.

Taxonomic treatment is broadly similar to that given in guides to NW Europe, except for a tendency to illustrate subspecies and forms in families where these have been distinguished in the past and where this usage is helpful.

In sum, I recommend this book to all interested in European and Mediterranean non-marine molluscs. I hope that it sells enough to justify a second edition which could make good the few weaknesses pointed out above. I am sure that it will provide an impetus to Italian malacologists and visitors to Italy to gather further information on the status and distribution of non-marine molluscs there.

David Long

# PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

## REPORTS OF THE COUNCIL 1994–1995

The Society announced with regret the deaths of 3 members, Mr M Whitehead, member since 1975; Mr J M Douglas, member since 1987 and Dr Joan Llewellyn-Jones, life member since 1958.

### *Changes to Society Rules*

At the Special General Meeting preceding the March 1994 Annual General Meeting, some important changes to the rules were made. The reallocation of tasks performed by Officers resulted in the creation of the new posts of Hon. Membership Secretary and Hon. General Secretary. Rewording of rules 10, 13 & 15 was necessary to comply with this. Rule 11 now allows for vacancies on Council to be filled by co-option as well as by ballot. Rules 4, 17 & 23 are altered so that changes in subscription fee, rules and other resolutions can be made at an AGM as well as a Special General Meeting. Rule 15 now allows for a Special General Meeting to be held at the recommendation of Council. Rule 19 covers publications generally to allow greater flexibility on the part of the Publications Subcommittee.

### *Change of Hon. Secretary*

Mrs Susan Davies retired from the post of Hon. Secretary at the March AGM and was succeeded by Ms J E Reynolds in the new post of Hon. General Secretary and Mr M D Weideli in the new post of Hon. Membership Secretary. Mr David Guntrip retired from his co-opted position as Minutes Secretary.

### *Other Council Positions*

In 1994 Dr Barry Colville began his second year as President. New Ordinary Members of Council for 1994/5 were Mr Palmer, Mr Brown and Miss Nelson. Mr Philp, Mr Tracey and Dr Honnor began their second year on Council; and Miss Foga, Miss Sawyer and Mrs Platts began their final year on Council. In February 1995 Miss Fogan retired from the post of Trustee and Dr Barry Colville was elected as her replacement. Mr Seccombe resigned as Treasurer in December 1994.

### *Publications*

The Society published 2 issues of the *Journal of Conchology* (Volume 35, Parts 1 and 2). Four issues of the *Conchologists' Newsletter* were published (Volume 7, Part 3, Numbers 128–131). The Society also published the Annual Programme card for 1994 and in December produced an updated Membership List.

### *Other Council Matters*

The Society's Display Boards were completed in February and during the past year they have been on show in Newbury, Hertfordshire and Flatford Mill. In April, as a result of attending the International *Partula* Propagation Group Workshop as Conchological Society delegate at London Zoo, Ms Reynolds 'adopted' a hybrid species of *Partula* snails on behalf of the Society. In May the Society affiliated to the British Trust for Conversation Volunteers in order to take advantage of their insurance scheme. For a very reasonable cost to the Society (under £50 per year) all members and other parties (up to 85 years of age) attending field meetings are covered for both Public Liability and Personal Accident up to £2M. The Society expects to continue to use this scheme in future. Other issues, such as the future of the Research & Reserve Fund, continue to be looked at in great detail.

1994 has been a decisive year for the Society. Simplification of the rules means that Special General Meetings are reserved for special purposes, rather than routine changes. The changes to Officers provide a more efficient service to all members through more logical organisation of the workload. Positive work is being done to publicise and promote the Society as a progressive and dynamic organisation.

Mrs Jane E Reynolds  
Hon. General Secretary  
March 1995

## TREASURERS REPORT FOR THE YEAR ENDED 31 DECEMBER 1994

Income exceeded expenditure by £1,149 (1993: £1,841) and the profit for the year after transfer to reserve was £497 (1993: £1,872). Broadly, the increase in subscription rate in 1993 was insufficient to cover additional incremental costs of producing the Society's publications.

**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND  
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1994**

**INCOME AND EXPENDITURE ACCOUNT**

	31 Dec 1994 £	31 Dec 1993 £
<b>INCOME</b>		
Fees and Subscriptions	13,238	11,256
Investment Income	2,528	2,736
Sales and Donations	1,398	936
	<hr/> 17,164	<hr/> 14,928
<b>EXPENDITURE</b>		
Publication Costs	11,981	8,993
Stationery and Postage	1,594	1,613
Meetings	906	830
Sundry Costs	1,534	1,652
	<hr/> 16,015	<hr/> 13,088
<b>Excess of Income over Expenditure</b>	1,149	1,840
Transfer from Publicity Reserve	182	618
Transfer to Reserve and Research Fund	(834)	(493)
Transfer to Life Members Fund	—	(93)
	<hr/> 497	<hr/> 1,872
<b>Profit for year</b>	<hr/> <hr/> 497	<hr/> <hr/> 1,872

Income from subscriptions was 18% up from last year at £13,238 (1993: £11,257), reflecting the increase in the subscription rate and the successful chasing of arrears. However, despite the increase in rates, the income from ordinary members was approximately the same as last year reflecting the decline in the number of ordinary members.

Income from Deeds of Covenant was approximately 35% lower at £238 (1993: £367) arising from the expiry of a number of old deeds that were not renewed. The Treasurer cannot stress too highly the need for tax paying members to enter into Deeds of Covenant which give the Society on average an additional £7 per year for each member who enters into a Deed, at no cost to the member.

Investment income fell slightly at £2,528 (1993: £2,737). However now that interest rates are increasing this trend should be reversed in 1995. Sales continue to increase due to the sales of Society merchandise and the continuing efforts with regard to the sale of publication back issues. Total sales were up 50% at £1,399 (1993: £936) and the Treasurer extends his thanks to all those involved.

Publication costs were up approximately 33% at £11,981 (1993: £8,993). This was mainly due to the production of a number of covers for the Journal at a cost of £1,316 which should last for a considerable period of time. However, both the underlying costs of the *Journal of Conchology* and *The Conchologists' Newsletter* increased by about 24% and 17% respectively. The 1994 issues of the Journal (excluding postage) cost £7,400 (1993: £5,900) and the Newsletter (including postage) cost £3,050 (1993: £2,600).



PROCEEDINGS

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND  
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1994

BALANCE SHEET

	31 Dec 1994 £	31 Dec 1993 £
<b>ASSETS</b>		
Investments at Cost	17,372	17,372
Cash	15,447	17,928
Debtors	1,508	1,263
	<hr/>	<hr/>
	34,327	36,563
<b>LIABILITIES</b>		
Creditors and Accrued Charges	1,410	4,686
Advance Subscriptions	—	109
Life Members Fund	4,614	4,614
Reserve and Research Fund	6,672	5,838
Publicity Reserve	—	182
	<hr/>	<hr/>
	12,696	15,429
<b>Net Current Assets</b>	<hr/>	<hr/>
	21,631	21,134
	<hr/>	<hr/>
<b>Represented by:—</b>		
Capital Account brought forward	21,134	19,262
Profit for the year	497	1,872
	<hr/>	<hr/>
	21,631	21,134
	<hr/>	<hr/>

A D Seccombe  
Honorary Treasurer

N Light

D Worth  
Honorary Auditors

Sundry expenses include the cost of a new computer plus printer of £1,266 which is currently being used by the Society's Honorary Secretary. The previous computer was sold to the previous Honorary Secretary at its full second hand value. This sale will be reflected in the 1995 accounts.

Cash balances fell between 1 January 1994 and 31 December 1994 owing to the settlement of the Society's creditors during the period.

Once again, it is considered that the Life Members Fund is adequately financed. Accordingly, the investment income allocated to this fund has been re-allocated to the Reserve Fund which now stands at £6,682.

In summary, the Society continues to be in a reasonable financial position. However, rapidly increasing world paper costs will undoubtedly increase the costs of the Society's publications for 1995 and years to come; likewise, the annual increase in postage costs. Accordingly, in the absence of a large influx of new members, or a significant new source of revenue the financial position may deteriorate in the short term. It is for this reason that I wish to draw all members' attention to my comments regarding the covenanting of their annual subscriptions referred to above.

Alan Seccombe  
Honorary Treasurer

## PROGRAMME SECRETARY'S REPORT MARCH 1995

The 1994 programme comprised 7 indoor meetings held at the Natural History Museum in London, a joint meeting with the Malacological Society of London and the Society for the History of Natural History held at Burlington House, 9 field meetings and 2 workshops.

Lectures at indoor meetings were given by: Paul Pearce Kelly (London Zoo), Dr. Barry Colville, Professor Malcolm Edmunds (University of Preston) and Dr Tony South. At the November meeting short presentations on marine and non-marine mapping projects were given by Jan Light, Ian Killeen, Julia Nunn, Michael Kerney, Tony Smith and Michael Weideli. The December meeting comprised Members' slides, exhibits and a quiz.

*Malacological Pioneers* was the theme of the October meeting organised by Elizabeth Platts at the Linnean Society's rooms in Piccadilly. Papers were given by David Heppell, Ron Cleevely, Peter Davies, Robert Cameron, Helena Chesney, Fred Naggs, Laurence Cook, Richard Preece and Ian Killeen, Peter Dance.

Field meetings continue to be well attended and act as a focus for the Society's recording activities. Meetings were held at the following venues: Blockley, Gloucs (Leader: David Long), Mid Wales (Leader: Dave Boyce), Newtimber, Sussex (Leader: Brian Coles), Anglesey (Leader: Tom Clifton), Poole Bay (Leader: Jan Light), North Foreland, Kent (Leader: Ian Killeen), Guernsey – joint meetings with Porcupine (Leader: Roger Brehaut), Northumberland (Leader: Rosemary Hill), Newbury, Berks (Leader: Michael Weideli).

A workshop on British Slugs, tutored by Stella Davies was held at the home of Jan Light in Godalming. The Society's tenth Molluscan workshop was held at the home of Judith Nelson in Woking. Both of these events were successful as they act as a forum for discussion and provide members with an opportunity to receive tuition on difficult groups and get material identified.

The Society is grateful to all the speakers at the above meetings and to the organisers of the field meetings and workshops.

Ian Killeen

## RECORDER'S REPORT: MARINE MOLLUSCA MARCH 1995

Marine recording activities continue to be focused on regional mapping schemes. In particular the *Atlas of the Marine Mollusca of the Channel* is being actively promoted both in the UK and overseas. A base map has been prepared on a 6' × 6' grid and two major contributions during the year towards this initiative were made. A joint meeting with PORCUPINE to Guernsey yielded a substantial amount of new data from the area including several new Sea Area records. It is of note that *Haliotis tuberculata* was found commonly on one of the shores possibly as a result of attempts to augment natural recruitment by offshore spat-laying. Work with MAFF in the East Channel produced several hundred sublittoral records from the area between Hastings and Dungeness.

Other areas continue to be actively mapped. Details of the Irish and West Scottish work were presented at the November Mapping meeting by Julia Nunn. This will result in two major Atlases of which the *Marine Mollusca of West Scotland*, coordinated by Shelagh Smith, is in final preparation. To consolidate data, a week's ship time was provided by SAMS to dredge the Firth of Lorn and adjacent areas. Comprehensive lists were obtained from 40 stations. Publication of the Irish Atlas is planned for the year 2000 and to this end Julia Nunn is carrying out systematic shore and diving surveys. Active recording in other areas is centred on S23 and S24 by Tom Clifton who is now maintaining working atlases for both areas and led a recording meeting to Anglesey.

Many notable records have been submitted during the year, mostly as a result of the surveys mentioned above. In particular *Alvania abyssicola* merits mention as Seward (1990) considered this species to be extinct in our area. Live specimens were found at several stations in the Firth of Lorn confirming it to be extant. Other species rarely recorded or new to this rich area are: *Nematomenia banyulensis*, *Cima minima*, *Melanella frielei*, *Hinia pygmaea*, *Liostomia clavula*, *Eulimella ventricosa*, *Rhizorus acuminatus* and *Thyasira pygmaea*. Interest in *Paludinella littorina* by the Conservation Agencies resulted in a detailed survey to determine its distribution in Pembrokeshire. This confirmed its presence at Broad Haven and led to the discovery of a previously unknown thriving population on the north coast of Caldey Island.

The production of the JNCC report no. 165 as a supplement to Seward's *Distribution of the marine molluscs of north west Europe* (1990), effectively marked the end of this chapter of marine recording in British waters. Although most of our recording is focused on more detailed mappings there is still a need for presenting data on a national basis in some form. I propose that the use of Sea Areas be continued for administrative purposes but for visual presentation of national distributional data the system of ICES squares (30' × 30') should be used. Details will be resolved during the coming year.

I would like to thank all those who have submitted records to me during the past year.

Jan Light

## RECORDER'S REPORT: NON-MARINE MOLLUSCA

Publication of the *Atlas of land and freshwater Mollusca of Britain and Ireland* is at last in sight. All data have been computerised and map production can now begin. Our thanks are due to Paul Harding and his staff at Monks Wood for undertaking this work under difficult circumstances. If all goes well the *Atlas* should be a physical reality by this time next year.

The following new vice-comital records have been verified since the last Report (*J. Conch., Lond.* **35**, p. 187). Unless stated otherwise, all date from 1994–5.

Cornwall West (1): *Hygromia cinctella*, Newquay (10/8161), Sheila Harper.

Devon North (4): *Spermodea lamellata*, Skentaway Bridge, Brayford (21/7037), G. Musker; *Toltecia pusilla*, Eggesford (21/6811; garden centre); D. E. Bolton.

Somerset South (5): *Valvata macrostoma*, West Sedge Moore, Curry Rivel (31/3526), D. J. Gibbs; *Gyraulus laevis*, Chilton Trinity (31/2939); *Pisidium pseudosphaerium*, Wellington Canal Basin (31/1221), both A. G. Smith.

Berks (22): *Hygromia cinctella*, Beenham (41/5868; garden), per M. Weideli.

Brecon (42): *Spermodea lamellata*, *Boettgerilla pallens*, Pwll-y-wrach (32/1532), I. J. Killeen.

Cardigan (46): *Pomatias elegans*, Mwnt (22/1951; shells only), A. P. Fowler and A. O. Chater.

Flint (51): *Limax maculatus*, Greenfield (33/1977), A. Norris.

Anglesey (52): *Vertigo geyeri*, Cors Erddreiniog NNR (23/4782), B. Colville and Elizabeth Howe; *Spermodea lamellata*, Fedw Fawr, Llangoed (23/6081), A. O. Chater and A. P. Fowles; *Arion hortensis*, *Zenobiella subrufescens*, Tynyngongl, Benllech (23/5082), Dorothy Marriott.

Leicester (55): *Macrogastra rolphii*, Skeffington Wood (43/7503), J. Daws.

Chester (58): *Arion owenii*, Malpas (33/4844), I. F. Smith.

Lancaster South (59): *Monacha cantiana*, Rainford (34/4602), C. Felton.

York North-east (62): *Vertigo geyeri*, Thornton Dale (44/8584), D. J. Lindley.

Cumberland (70): *Planorbarius corneus*, Unthank (35/4236; artificial ponds), B. Colville.

Dumfries (72): *Milax gagates*, Annan (35/1966), A. T. Sumner.

North Ebudes (104): *Vallonia pulchella*, Ord, Skye (18/6113), Nicole Limondin.

Sutherland West (108): *Cepaea nemoralis*, Scourie (29/1544), Nicole Limondin.

Cork Mid (H4): *Tandonia rustica*, Blarney (W6075), M. Cawley.

Sligo (H28): *Cernuella virgata*, Rosses Point (G6240), M. Cawley, 1990.

Leitrim (H29): *Pupilla muscorum*, *Milax gagates*, Tullaghan (G7858); *Limax cinereoniger*, Glencar (G7643); *Helicella itala*, Dromod (N0589), all M. Cawley.

The year has seen some major discoveries. The most unexpected perhaps is of *Tandonia rustica* in Ireland. This central European slug was previously known in the British Isles only from one locality in Kent, discovered in 1986. The habitat at Blarney is mixed deciduous woodland. What is of interest is that references to an unusual spotted *Milax* seen at Blarney and at Aghanda (W8562; H5) in 1907 make it likely that *T. rustica* has long been established in Co. Cork and decrease the possibility that it is a recent introduction into the British Isles (*Ir. Nat.* **16** (1907) p. 276) *Proc. R. Ir. Acad.* **B29** (1911) p. 75). Unlike other British milacids *T. rustica* is not synanthropic.

Also of importance is the discovery of *Vertigo geyeri* in Anglesey and Yorkshire. Both sites are calcareous spring-fed mires with *Schoenus nigricans*, not unlike the single previously known British locality for this species at Sunbiggin Tarn, Cumberland. The habitat at Cors Erddreiniog is described by Dr Colville in *Conchologists' Newsletter* no. 130, p. 376. It must be noted that a poorly preserved shell of *V. geyeri* from this fen was wrongly identified in my Recorder's Report in 1990 as *Vertigo lilljeborgi* (*J. Conch.* **33**, p. 378; see also **34**, p. 185); this erroneous record must be deleted from the Census.

A discovery of interest is of *Pomatias elegans* on the Cardiganshire coast. A prolonged search resulted in the finding of a dozen or more shells, in mole hills in calcareous grassland over shell sand. Some appeared very fresh, suggesting an age in decades at most. Another significant extension of known range is of *Cepaea nemoralis* living on blown sand by the sea in West Sutherland, nearly a hundred kilometres north of its previously recognised limits in Skye and in the Great Glen, and within an area dominated by *C. hortensis*. Also noteworthy is the discovery of *Spermodea lamellata* in valley scrub in Devon, the first report of this species from south-west England other than as a fossil. *Macrogastra rolphii* in an ash/hazel wood in Leicestershire also deserves mention.

Among introduced species, *Hygromia cinctella* has been found in West Cornwall and in Berkshire. Known a few years ago only from South Devon, this attractive mediterranean helcid is evidently rapidly becoming established in gardens and waste ground over a wide area of southern England, and has been noted so far in ten vice-counties.

The outstanding find among freshwater species is of *Valvata macrostoma* in Somerset. The habitat is a marshland drainage ditch choked with *Glyceria* and *Scirpus*. Though it is a species perhaps not entirely unexpected in the Somerset levels, the discovery greatly extends to the west the known range of this nationally declining rarity. (The nearest occurrences are in the Avon valley in Hampshire, last reported in the 1950s.) New to v.c. 5 also is *Pisidium pseudosphaerium*; this very local bivalve has been found recently in several places in North Somerset (v.c. 6) and is evidently not uncommon in the area.

M. P. Kerney











## INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr P. G. Oliver, National Museums & Galleries of Wales, Cathays Park, Cardiff CF1 3NP.**

**PAPERS** Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

**COMMUNICATIONS** These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

# Journal of Conchology

Vol. 35, Part 4, January 1996

## Contents

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	PAGE
PAPERS	
J. HERMIDA, P. ONDINA AND A. OUTEIRO—Ecological Factors Affecting the Distribution of the Gastropods <i>Aegopinella nitidula</i> (Draparnaud, 1805) and <i>Nesovitrea hammonis</i> (Ström, 1765) in Northwest Spain . . . . .	275
FRANCISCO FERNANDES, EMILIO ROLÁN AND JORGE OTERO-SCHMITT—The Genus <i>Crassispira</i> (Gastropoda, Turridae) in West Africa . . . . .	283
D. S. BROWN—Georg Mandahl-Barth (1910–1994): His Life, Publications and Described Taxa . . . . .	303
A. A. WARDHAUGH—The Terrestrial Molluscan Fauna of some Woodlands in North East Yorkshire, England . . . . .	313
LUIS RICARDO L. SIMMONE—A New <i>Amphithalamus</i> Carpenter, 1864 Species (Gastropoda, Rissoidea, Barleeidae) from the Brazilian Coast . . . . .	329
GIUSEPPE MANGANELLI AND LEONARDO FAVILLI— <i>Xerosecta giustii</i> A New Hygromiid from Tuscany (Italy) Close to Extinction (Gastropoda, Pulmonata: Helicoidea . . . . .	335
J. GERLACH—The Taxonomy and Affinities of the Genus <i>Priodiscus</i> (Mollusca; Gastropoda Streptaxidae) . . . . .	357
W. WELLENS— <i>Coriocella jayi</i> n.sp. a new Lamellarid Species (Gastropoda: Prosobranchia) from Reunion and Mauritius . . . . .	369
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE . . . . .	377
C. P. PALMER <i>Petricola lithophaga</i> in England . . . . .	377
JUAN CIGARRÍA <i>Anadara inaequivalvis</i> (Bruguière, 1789) in the North Atlantic . . . . .	378
REVIEWS . . . . .	381
PROCEEDINGS . . . . .	383







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